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CONTENTS

1 **Redirection for the Corps: Perspectives**
by Lt. Gen. F.J. Clarke and Roland C. Clement

8 **Ocean Exploration: A Shirt-Sleeve Approach**
by Gilbert T. Rowe

15 **Waste Into Wealth**
by S.S. Searle and C.F. Kirby

22 **Operation Noah II**
by Mary Ann Striffler

24 **Unbeaten Graduates Enter Water Resources Arena**
by Benjamin C. Dysart III

29 **Anchor on the Castle**
by Seymour Reitman

37 **Early Preservation of "Pleasuring Grounds"**
by Francis X. Kelly

42 **Events, Deeds & Deliberations**

Comments on topics in this publication are invited. Send to:
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Cover: Western Maryland's Savage River, often a mere trickle, becomes a torrent of white water during U. S. Olympic White Water Trials for canoes and kayaks. The Corps of Engineers performs the transformation. See page 43.

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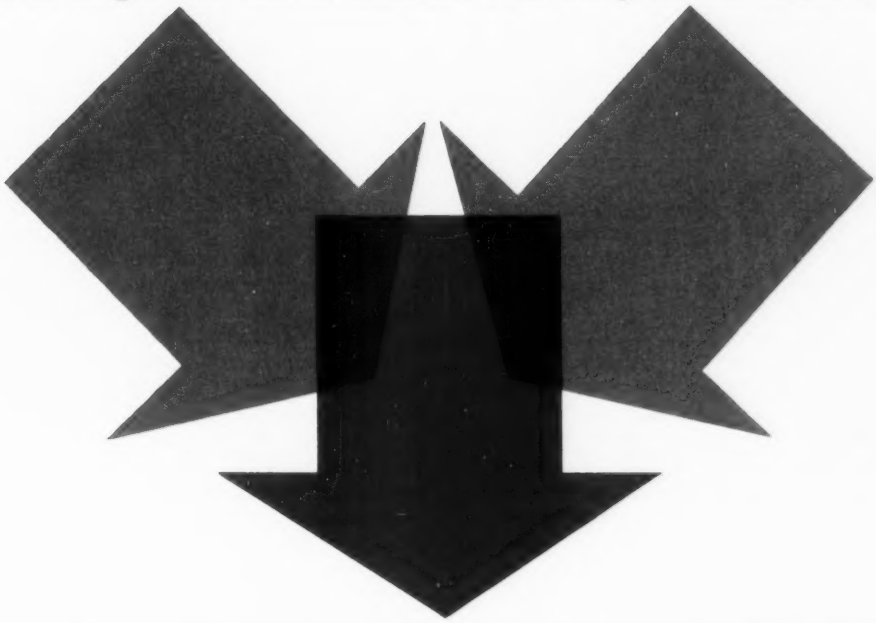
Black footed ferret on back cover and geese in flight on page 4 — Luther C. Goldman, Bureau of Spott Fisheries and Wildlife.

Pictures depicting environmental inventory examples on pages 4,5 and 6 include: from National Park Service the lighthouse by Ben Butterfield; rain forest by Jack E. Boucher; historical trail and coastal scene by M. Woodbridge Williams; and restored home and waterfall. The bald eagle is by Robert M. Ballou, Bureau of Sport Fisheries and Wildlife; the "thunder egg" by U.S. Geological Survey; and the trout stream by Bureau of Outdoor Recreation.

The Chief of Engineers' Environmental Advisory Board After Two Years



REDIRECTION FOR THE CORPS

The Recipient's Perspective

by Lt. Gen. F. J. Clarke

The Advisory Board Chairman's Perspective

by Roland C. Clement

General Clarke

Two years ago when I established the Environmental Advisory Board, the time was one of rapidly intensifying concern for environmental matters, and also rapidly evolving administrative procedures occasioned by the passage of the National Environmental Policy Act. I wanted a Board that would help me steer a course through the turbulence caused by the Nation's newfound environmental awareness. The advice received even from the very beginning proved useful.

Almost everything the Corps does in its water resources activities alters the environment in some way. For that reason alone, we have had a great deal to talk about. But progress most often is the result of deliberate but steady steps. I had to be sure the Corps' steps were the right ones and taken in the right direction.

Among the things the Board was asked to do are:

a. Examine the Corps' existing and proposed policies, programs and activities from an environmental point of view, to identify problems and weaknesses and suggest how these can be remedied.

b. Advise on how the Corps can improve working relations with the conservation community and the general public.

c. Advise on environmental problems or issues pertinent to specific plans or programs.

d. View its responsibilities within the context of the present and the future, rather than dwelling on past problems.

The redirection of the Corps and influence of the Board became apparent two months after its establishment when I issued a policy statement on the environment. This policy, in consonance with the National Environmental Policy Act, gave special attention to the full exploration of alternative solutions which would preserve resource options for future generations and strongly encouraged broad public participation in Corps planning. The four general objectives of the policy are:

a. To preserve unique and important ecological, aesthetic, and cultural values of our national heritage.

b. To conserve and use wisely the natural resources of our Nation for the benefit of present and future generations.

c. To enhance, maintain, and restore the natural and man-made environment in terms of its productivity, variety, spaciousness, beauty, and other measures of quality.

d. To create new opportunities for the American people to use and enjoy their environment.

These objectives were translated into guidelines governing the Corps of Engineers Civil Works program and published later in 1970.

Since the Board's formation, we have met quarterly in two-day sessions at my office and at other locations across the country. When the major subject concerned a particular geographic area, our meeting sites have been near the localities under consideration. We have met in Vicksburg, Miss., San Francisco, Calif., Baltimore, Md., Warrenton, Va., and Louisville, Ky. The Director of Civil Works as well as others from the Corps have attended the meetings with me.

The Board has been valuable in providing an environmental sounding board for proposed policies and actions of the Corps and has provided the perspective and perception needed to ensure proper consideration of the environmental aspects. The Board has helped in sorting out real problems of environmental concern from emotional ones. The Board has also encouraged a number of activities, policies and programs — for example: flood plain management activities and the integration of flood plain management principles in planning. I would give the Board credit for the heightening of our environmental awareness that has taken innumerable forms such as wetland policy, the handling of environmental impact statements and, of course, the Corps' environmental policy and guidelines. *In particular, I consider the Board responsible for initiation of our Environmental Reconnaissance Inventory program.*

As far as the future is concerned, I hope to see the Board devote considerable attention to our major efforts in three important new fields. Urban studies and water management studies promise a significant return to federal dollar investment in the effectiveness of treating and utilizing the liquid wastes from urban areas. Deep ports may be constructed by the United States to handle the supertankers already common in world commerce. The environmental ramifications of such work are significant, and we are studying the problem on all of our coasts. Dredging to keep our existing harbors and waterways open presents environmental problems in the disposal of the dredged material, a potentially valuable resource in itself. We are embarking on an investigation of improved methods and policies that will have major environmental implications for our Nation's coastal wetlands and lowlands. We will be seeking the advice of the Board on all of these matters.

Looking back over the past two years, I compliment members of the Board on their constructive approach to environmental problems, their good advice, and their continued willingness to work with the Corps in matters where short answers and easy solutions have not been possible. Members of the Board have placed on the line their standing in what at times tends to be a rather critical and impatient community. They have been willing to do this for what they and I are convinced is a worthwhile cause and I admire them for it. With the advice of the Board, the Corps is committed to work toward a continuing improvement of our policies and procedures in accord with the environmental policies as developed by the President, the Congress and the Courts.

Mr. Clement

When I first accepted General Clarke's invitation to join a new Environmental Advisory Board in 1970, a friend who leads another national citizens group concerned with good land use in America said quite bluntly that I had blundered. "The only way to redirect the Corps of Engineers," he said, "is to abolish it." Shortly thereafter George Laycock's book, *The Diligent Destroyers,* and more recently, Arthur E. Morgan's *Dams and Other Disasters,* confirms what is at least one widespread view of the Corps' environmental role. I am not unsympathetic to these concerns, but since none of these critics is likely to abolish the Corps, it has seemed to me that if any redirection is to come it will yield chiefly to understanding and to the facilitation of new directions. This is what the Board is trying to do by persuasion.

There are six of us, all members of the environmental establishment. Lois Sharpe of Washington, D.C., is a geologist who did ten years of Corps watching for the League of Women Voters before joining the Board in May 1972. Richard Backus of Woods Hole Marine Laboratory, a specialist in the fishes of the North Atlantic, also joined us in May. They filled two vacancies on the Board.* Members since the beginning include L. Keith Caldwell, professor of government at the University of Indiana, and author of *Environment: a Challenge to Modern Society;* Harold L. Gilliam, conservation and science editor for the *San Francisco Chronicle;* and Richard H. Pough of Pelham, N.Y., an M.I.T. engineer turned environmentalist, author of three *Audubon Bird Guides* and now president of Defenders of Wildlife, Inc. Like Mr. Pough, I am a field ornithologist, a generalist in environmental science, and vice president of the National Audubon Society.

The Corps has a long and proud tradition of engineering services to the Nation, and its help in navigation and various construction services has been widely appreciated. Both the President and the Congress have called on it to do jobs that would be difficult to do by the usual interaction between politics and private enterprise. When, beginning in 1928, the Corps became involved in flood control programs, however, its impact on the environment grew rapidly and its expertise in engineering no longer sufficed to guide its broadened role.

The new public awareness of, and concern about, environmental deterioration which culminated in the National Environmental Policy Act (NEPA) of 1969 created a "whole new ball game," as General Clarke and others have ever since tried to explain to the Corps' old constituency, the developmental interests. It was the desire to bridge this new gap in public concern that led the Corps, first among all the land-use agencies, to create its own Environmental Advisory Board, perhaps on the assumption that it is more confortable to argue differences of opinion privately than in the glare of courtroom debate, since the courts are currently a principal means of settling these differences of opinion about national policy.

It takes time to get acquainted. And our first year was devoted to exploring one another's outlooks, studying Corps procedures, and visiting districts where the Corps' operations are focused. Those among our critics who think the world's business is run by conspiracies, who insist on maintaining antagonistic postures, or who think all attempts to rationalize must result in the brainwashing of one side or the other, have of course pointed out the Board refused to get involved in specific controversies over particular projects. But we felt it was essential to get to know one another as persons before expecting to reorient one another as professionals; and most of us have not only enjoyed but profited from the Corps' hospitality, and are more effective for the private consulting roles we agreed to play.

Two years of Corps watching has convinced me — and most of my colleagues, I feel sure — that the Corps is more scapegoat than culprit in the current environmental controversy. The general confusion that plagues public discussion of these matters seems to me a result of a naive political outlook, more specifically, of a failure to identify the "structural" causes of what disturbs us. We seldom inquire into an agency's congressional mandates, for example, or into what is possible and what impossible, especially given the defined statutory procedures and the "public demands" the Corps was organized to satisfy. Those who do not recognize the distortions of "public demand" inherent in our present form of representative government are doomed to belabor scapegoats to the end of their days. Correcting these abuses calls for the much more demanding task of building fences to keep the neighbor's cows out of the back pasture. This is up to you and me because the Congress has of course not authorized the Corps to build political fences or shape national policy by decreeing policies of no growth.

Our problems arise from the fact that after 200 years of being satisfied with *Growth* as a sole national objective, Americans are discovering that material things do not necessarily make for happiness. A cynic might answer that happiness is still easier to achieve with plenty of goods or the dollars they represent; but basic necessities aside, the times prove him wrong.

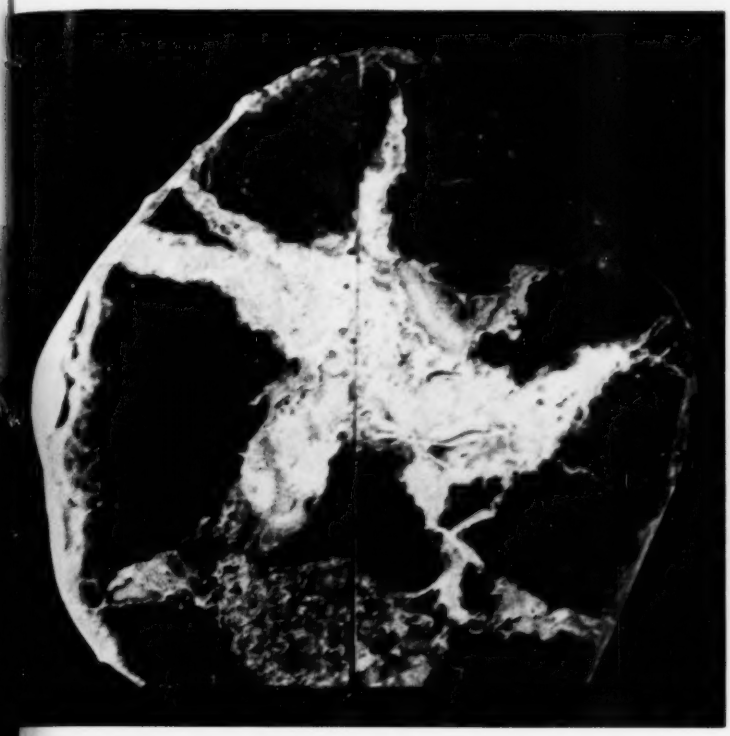
Our Nation has a material standard of living two or three times that of any other nation, but we are torn apart because of poverty, taxes, racism, pollution, Vietnam and alienation. The time has come to balance our national accounts more equitably, and this is what the *Environmental Revolution* is all about. NEPA is a first step in ensuring that future growth shall not further impoverish the quality of life by carelessly destroying the

*Vacancies were created by the expired terms of Charles H. W. Foster and Charles Stoddard who were charter members.

Flyway roosting and feeding areas will be mapped as part of an environmental inventory.

A mapping of historic trails will be part of the inventory.

Historical sites form a tie to our past and give us a sense of belonging.

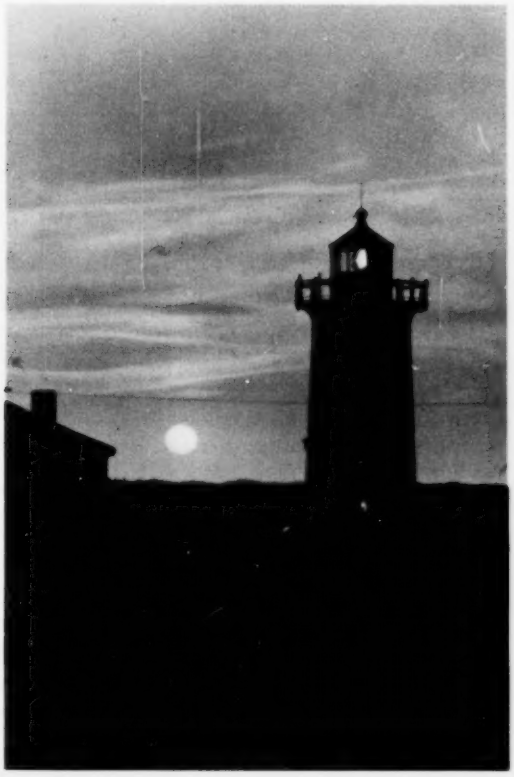


Locations of unusual rocks such as this "thunder egg," which is recognized for its aesthetic and geological value, will be included.

Trout streams will be traced across the inventory map.

Habitats of the bald eagle and other endangered species will be marked.

Man's own additions to the landscape often have cultural values that should be protected.



amenities of a diversified environment. Being a first step, it articulates — stammeringly perhaps — a search for a new national value system that will include more than economic growth. Such reconstructions are always uncomfortable and often bring reactions. Already, some exploiters are lashing out angrily at NEPA, but it is illogical to accuse environmentalists of upsetting our national priorities. New circumstances did this, and these changes were the unanticipated results of the growth we Americans boasted of until yesterday.

How does one protect the environment? Since *man is part of the environment,* defining it is made difficult by the self-relatedness of every definition. We can, however, identify physiographic features that make for pleasant

Physiographic features that make for pleasant landscapes will be identified.

This rain forest is part of an ecosystem that has an integrity of its own. A melange of vegetation makes it possible for various animal species to exist there interdependently.

The special value of coastlines will be taken into account.

landscapes; a melange of vegetation that enhances these landscapes and makes it possible for various animal species to exist there interdependently; and this animal life, sometimes obvious but more often small and inconspicuous, in turn plays important ecological roles and interests man in its own right. The first flash of awareness in this ecological area usually leads defenders of the *status quo* to respond with a cosmetic approach, that is, landscaping and the planting of trout or pheasants. Ultimately, however, ecological awareness must involve recognition that ecosystems have an integrity of their own, one which must not be violated except with due regard to retaining an adequate balance between man's works and those of nature. Finally, we recognize that man's own additions to the landscape have cultural values we should protect where possible because they form a tie to our past and give us a sense of belonging.

The Corps has known as much as anyone about the physiography and hydrology of the landscape, but like our entire civilization until recently, it has neglected the importance of the biota and cultural artifacts in developing benefit-cost analyses for project proposals. Indeed, our laws dictated a narrow focus, and still do to a large extent. The environmental impact statement required of every Federal project proposal by NEPA's Section 102(c) is an attempt to make the above-mentioned environmental factors explicit, not with the object of stopping all development, but to help people decide whether a given project is really worth it from the point of view of the total public interest.

During its second year with the Corps, the Board focused on helping devise an *Environmental Inventory* which will assist every Corps district map its resources — not only hydrologic and physiographic, but biotic and cultural. This will equip the district engineer and his planning staff with the essential environmental data that must be weighed in every benefit-cost analysis when a project is proposed to meet local demands for development. Four pilot approaches to the compilation and display of such environmental data are now underway — in Vermont, the Carolinas, and Washington. There is a good deal of skepticism about the value or reliability of benefit-cost analysis; but this technical problem aside, a spelling out of the alternatives and of the trade-offs involved is what we are all after.

The Section 102(c) statements unfortunately involve more of the paperwork which has become the bane of every organization. Given our rudimentary understanding of "the environment," these statements at first did little to enhance understanding of the trade-offs involved in every manipulation of the landscape. However, what are now called "second generation" impact statements do this increasingly well, and it is widely acknowledged in Washington that the Corps has done this better than any other agency. Even so, since the courts have decreed that they were not judging projects on their merits in granting injunctions for failure to comply with NEPA's Section 102(c) requirements, there is now a great temptation to reduce the preparation of environmental impact statements to a routine that will satisfy the law and thus, in the view of some, "get the environmentalists off our backs." This would be a tragic miscarriage of justice, and the Board, in its advice to the Chief of Engineers, is emphasizing the responsibility of making full environmental costs truly explicit, and is thus helping the Corps help the American people better decide how to define *progress* as they move toward the year 2000.

The National Environmental Policy Act of 1969 unfortunately failed to provide a crucial requirement, that of remanding environmentally expensive projects back to the Congress for review. Instead, a developmentally minded Public Works Committee of the Congress has already authorized some $10 billion in water-related Corps projects that are often not in accord with the public's new wishes about national priorities. It does little good to plead the academic rules of civics and say that the public should vote for more environmentally conscious legislators. It will in time, but the annual omnibus bills for rivers and harbors currently prevent intelligent citizen participation in land-use policy. Citizens therefore resort to the courts in an attempt to stop questionable projects. These conflicts are the inevitable result of authorizing public works projects without first agreeing on a national land-use policy, and the environmentalists must learn to shift their demands to the Congress if these conflicts of interests are to be reduced. It is almost certain that we shall argue values for several years to come. Because we must do this civilly, if we are not to destroy ourselves as a Nation, statesmanship has become an imperative.

We need, somehow, to recognize that we live in two worlds: the world we have built for ourselves within the world of *nature,* and *nature's* world, which has been and remains the substrate of our world. We are currently engaged in a fateful struggle to keep these two worlds integrated against the inflated notion of a few that man can now get along without *nature.* Ecologists — those scientists who study the interrelationships of living things with their environment and who know more about such things than the rest of us — are warning that our demands and our careless technologies are stressing the earth's ecosystems unfavorably. It is easy to argue that no one can "prove" this at present, but there are plenty of signs that prodence is the better choice right now. This is certainly one reason for resisting the easy generalization that environmentalists are "against people" just because the environmentalists argue that population is growing faster than we can properly accommodate it. We really know so little about ourselves and our environment that our powerful technologies have become a hazard to us. We need to preserve options for another day, when, hopefully, we must know better how to do what really needs doing. If the Environmental Advisory Board can convince the Corps that this ecological point of view is sound, it will have served its purpose. ■

Ocean Exploration:
A SHIRT-SLEEVE APPROACH

by Gilbert T. Rowe

We are SCUBA diving in an area near the sewage sludge dumping grounds 10 miles off New York City. Water depth is about 100 feet and visibility, with lights, ranges from about 5 to 15 feet. The bottom, which is at the inshore head of the Hudson Gorge, is an organic-rich mud.

We are measuring the rates at which the sea floor and its biota use oxygen from the water. To take the measurements, we must place an "in-situ respirometer" down onto the mud, by hand, diving below a buoy we set prior to the experiments. Although the instrument stays down all day and sometimes overnight, we must return to the surface soon after deployment to avoid extensive decompression or the bends.

Ken Smith, Jr., and C. Hovey Clifford, two associates, are working with me and conditions demand that we make four dives a day. We become exhausted. Unexpected difficulties sometimes arise and we discover that we have been foolishly optimistic about the number of things we can accomplish in the few minutes of each dive. And then there's the matter of breathing nitrogen under pressure. During some dives we become forgetful and we even get a feeling of slight panic. We realize that these symptoms are due to the ever so subtle beginning of narcosis. It becomes increasingly apparent that this method of experimentation has its drawbacks. Yet, we chose SCUBA above conventional sampling from the surface because it put us right into the environment for this seasonal study.

We are not professional divers, but biologists who are forced to dive to conduct experiments. Compared to oil industry professionals, our depths and endurance requirements are child's play, but *any* use of SCUBA has limitations of time and area.

For example, the dumping off New York is primarily in three areas, each covering about 25 square miles. About 5 miles from the shore is the dredge spoils dump, offshore just over the head of Hudson Gorge is the sewage sludge, and about 5 miles southeast of that is the industrial waste disposal area, referred to by the local fishermen as the "brown water of the acid grounds."

In scope, too, our experiment has suffered from our sampling methods.

Part of the solution to our problems lies in the use of research submarines, called submersibles because they are small and have to be attended by a surface vessel. By allowing man to voyage to the ocean floor in his shirtsleeves, submersibles would obviate all the above problems. However, they are quite expensive and require a whole team of engineers and technicians.

But before we discuss the use of a submersible in this type of experiment, let's look at some of the reasons for man's exploration of the ocean bottom and the various alternative diving methods which have led to the use of submersibles.

The Sea and Man

At the Woods Hole Oceanographic Institution much of our biological work is basic research. This involves primarily the description of species new to science and the previously unknown habits, life histories, and distribution of the animals. Besides these pursuits, which for the present appear essentially esoteric, we are turning to applied problems with more tangible products. Most of this is near shore, in what oceanographers refer to as the "coastal zone."

Just what is the coastal zone? From a legal standpoint, it is a nation's or state's territorial waters. Although this has been historically recognized as extending 12 miles from the shore, some countries are now claiming as much as 200 miles or the whole Continental Shelf. It is the area where land meets sea; but how broad should we consider this zone to be? We could consider it to extend out below the tide level on to the Continental Shelf as far as the influences of land and rivers can be sensed with our oceanographic instruments. Or we could consider it the ocean area into which man and society have influence. Unfortunately, the latter will not be static in either time or space, for as populations increase, as poorer nations become industrialized societies and our marine technology increases in competence, the effects of man, good and bad, will creep farther offshore. This means we must understand not just the ocean's borders, but the whole ocean as a system. This is what diversified environmentalists should be doing.

The bands of ocean closely bordering our shores are among the most biologically productive zones of both the aquatic and terrestial worlds. The estuaries joining fresh water to the ocean are spawning and nursery grounds for many important fish species, the marshes and beaches are splendid recreational sites, and offshore there is a wealth of both living and mineral resources. However, industrialized societies, searching for places to dispose of wastes and hungry for energy, are threatening this heritage of sea wealth.

At present, resources in the ocean most susceptible to our exploitation are fish and fossil fuels. A third, hardly touched resource, is unused space. It is ocean "space" we exploit when we barge or pipe our wastes offshore. It will be space we use when electric power generating stations are built just over the horizon from crowded beaches.

Conceptually it is not difficult to imagine a generating station using deep, nutrient-rich, cold water for cooling.

Dr. Rowe is a biologist, Woods Hole Oceanographic Institution, Woods Hole, Mass.

The increased photosynthesis accrued from the upwelling water might be further enhanced by adding treated sewage effluent, always a good source for nitrates and phosphates. This could then be fed to shellfish whose growth rates could be optimized by proper control of the heated effluent. Little of the required technology for this is available now, but it should be before long if we are to evolve from simple exploiters to ocean managers.

Just prior to the United Nations Conference on the Human Environment, held in Stockholm in June, marine scientists met in Woods Hole for a Coastal Zone Workshop. The purpose of the meeting was to focus on the major problems of man's wastes and to suggest possible methods of solving the dilemmas facing us. Dr. Bostwick Ketchum, chairman of the Workshop Steering Committee, perspicuously said we need to "create change by design rather than by crisis."

With this attitude, Dr. Ketchum is leading many of us at Woods Hole in the pursuit of reality-oriented ecology. The prominent question among many of us, however, engineers and ecologists alike, is how we can best precipitate beneficial change that is an integral part of the total energy cycle. Man must put himself face to face with his environment.

Man in the Sea

How can we best realize the potential of ocean resources? Man must enter the sea itself, but by what means should he do so? Surface-ship sampling, especially for the biologist, is akin to trying to find out what a forest is like by flying over it in an airplane with a net lowered on a wire. The higher one flies, as with increasing ocean depth, the more difficult the sampling becomes. From this simple analogy, it is easy to understand why we are disenchanted with classical surface-ship oceanography.

Should we, then, put man himself into the ocean? Since the Cousteau-Gagnan invention of the demand air regulator for self-contained underwater breathing apparatus, SCUBA diving has become fairly common. The diver can spend unlimited time down to a depth of 33 feet, where hydrostatic pressure is equal to an additional atmosphere. But thereafter with each additional 33 feet and each additional atmosphere, difficulties begin to arise. At 297 feet, or 9 atmospheres, oxygen becomes toxic. Also at this depth, nitrogen is dissolved in the diver's blood and on too rapid an ascent, it forms bubbles which can cripple or even kill him.

In addition, nitrogen breathed under pressure is narcotic, being equal in effect to about one martini for every 50 feet down the diver ventures. As with alcohol, of course, susceptibility varies from person to person. Mixed gases, which have been used well past the 297-foot limit for compressed air, have helped eliminate nitrogen narcosis too. This, however, has not eliminated long decompression. Divers nonetheless are doing work at depths over 500 feet. This is magnificent progress, but the gas they breathe must be compressed to the thickness of a milk shake. We have very little idea what effects these exotic mixtures under pressure have on normal metabolic processes, but this is an extremely active field of research.

Ocean industry could never be where it is today without SCUBA and there will surely be a significant place for aquanauts in future work. But at the same time, I cannot imagine anyone working as effectively garbed in SCUBA gear as in his shirt-sleeves. Obviously, not enough has been done to make man more functional within the ocean's environment.

Man's frontiers have expanded in two opposite directions. While he has probed deeper and deeper into space, he has also rapidly developed submarines designed especially for the exploration of the ocean depths. The ocean floor, in spite of its proximity and its greater immediate relevance to man's problems, is probably less well-known than the moon's surface, but deep-submergence programs in industry and within ocean-oriented branches of government are bringing earth's remaining frontier within the eye-view of explorers. We are extending our domain into the remaining 70 percent of the earth's surface.

The Woods Hole Oceanographic Institution, with its deep submergence research vessel (DSRV) *Alvin,* is a world leader in deep-ocean exploration. As one of many ecologists able to use *Alvin,* I am trying to understand the perquisites of life on the ocean floor. Along with my colleagues who are mostly other animal biologists or geologists, I have seen the deep basins of the Gulf of Maine, the vast submarine canyons off the east coast, and the Tongue of the Ocean in the Bahamas, often up to a mile below the ocean's surface.

The submersible may soon be one of our most significant tools for ocean management and utilization. Until recently, even the fossil fuel industry seemed to consider them mere playthings. Researchers have shied away from submersibles because they are expensive and because their data acquisition methods are unusual compared to classical methods of blind surface-ship sampling.

There are, however, some very well-regarded companies that have invested in the development of submersible programs. A short, incomplete list includes the Perry *Deep Diver* and PC series, the Kawasaki *Shinkai* and *Hakuyo,* the Narwal *Access,* the Hyco *Pisces* and *Aquarius* series, the Bruker *Mermaid,* and the Westinghouse *Deepstar* series.

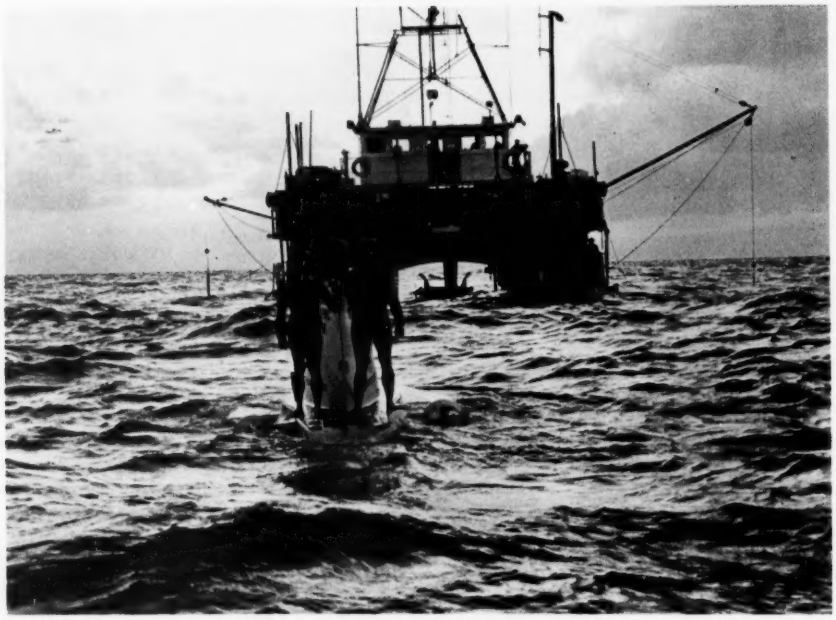
In spite of the availability of submersibles and the eagerness of their owners to ameliorate their capabilities and prove their utility, there are many situations where they will have no use. Presently, coastal zone work is often in the very shallow water of harbors and estuaries, and a submersible could not work effectively in the strong and erratic current which guarantees little or no visibility. For example, several of my associates and I, along with Jean Nichols, a graduate student, have been conducting a continuing investigation of the Woods Hole raw sewage outfall just offshore of our facilities. We could not sample the water adequately with conventional methods. Nevertheless, a submersible could not compete with the simplicity and ease of SCUBA.

On the other hand, another of our projects involves an attempt to make a solid reef out of baled, compressed

A Woods Hole Oceanographic Institution team discusses points before a dive in the Bahamas. From left are Rowe, the author; John Teal, senior scientist; Smokey Roberts, professional underwater photographer; Ed Bland, pilot; and George Broderson, crew chief of the tender "Lulu."

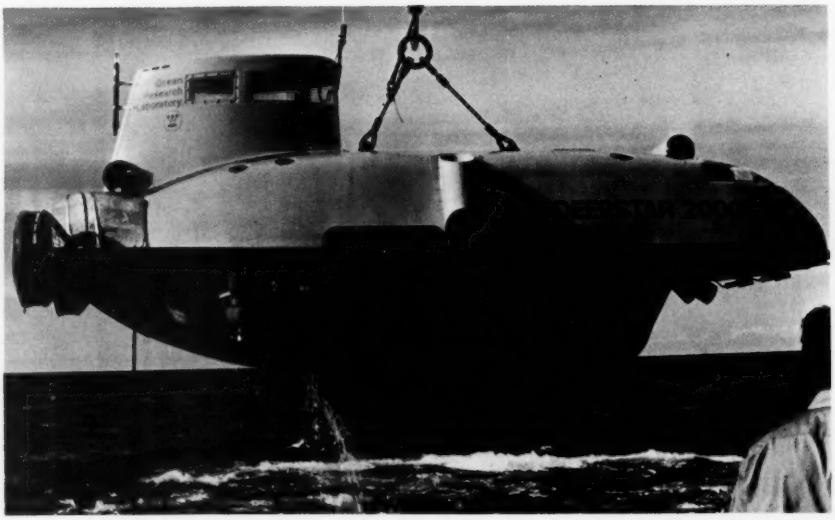
Boarding "Alvin" are Teal, left, and Rowe.

Divers John Porteus and Bill Page accompany "Alvin" for a final check before the submersible submerges.



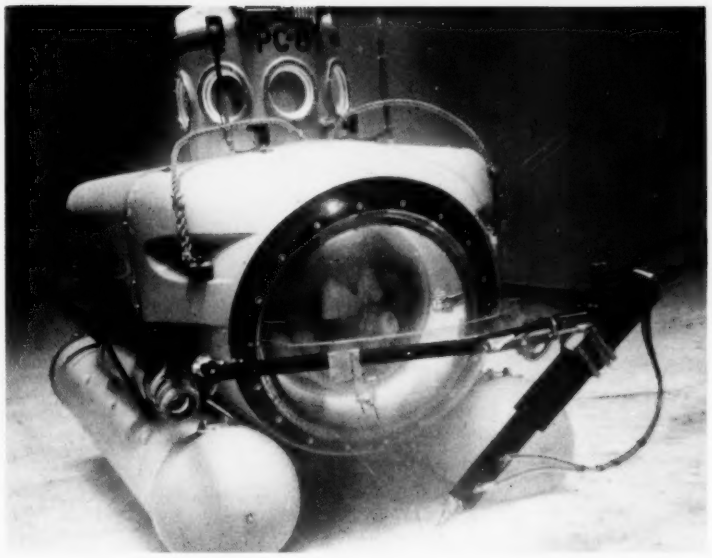
Pilot and the tender divers take the submersible back to the tender vessel.

A variety of submersibles, as indicated by those mentioned in this article, are being developed as tools for ocean management and utilization.



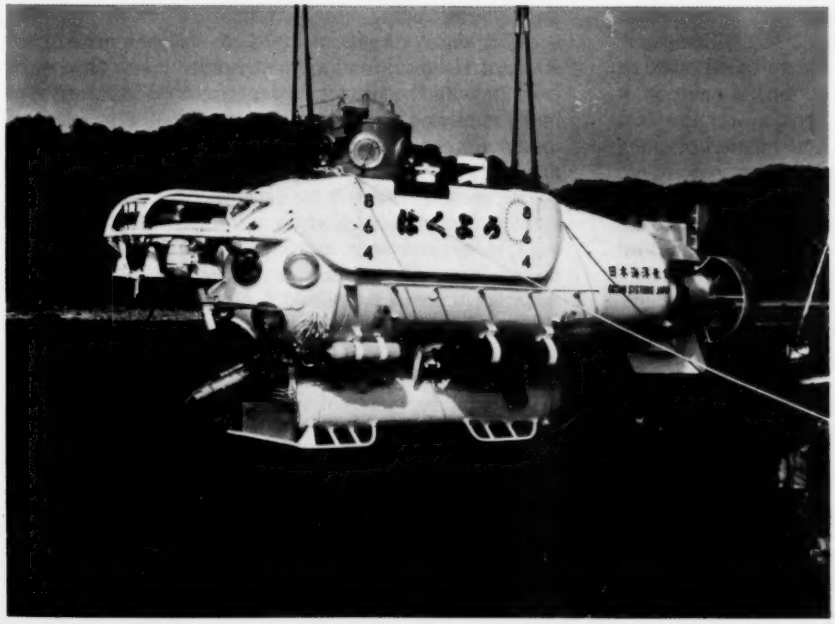
One of the Westinghouse "Deepstar" series.

The Perry "Deep Diver."



One of the Perry "PC" series.

Kawasaki's "Shinkai."



Kawasaki's "Hakuyo."

A model of "Access" by NARWAL of Toronto.

and encapsulated solid domestic refuse. The pilot investigation can only adequately be studied and managed using SCUBA. C. Hovey Clifford, my associate in this work, believes that moving the project offshore, perhaps to enhance deep, Continental Shelf lobster fisheries, will require active and continued monitoring by submersible-using ecologists.

A major hindrance to large scale use of a modest-depth submersible is cost, whether borne by the taxpayer or businessman. A vehicle having a 600 to 1,000 foot range depth, adequate observation ports, duration of 8 to 24 hours, photographic equipment, adequate maneuverability and a mechanical manipulator or arm would cost about $200,000. Buying a tender vessel would double that price. Operational costs alone for a single year, would, in turn, triple the latter amount. Of course, in buying each (the sub, tender, and support), there are ways to cut cost with compromise, but no adequate system could operate at much less expense.

Leasing from one of the established firms dealing in submersibles is probably a more acceptable alternative. For this, one might expect to pay from $1,000 to $5,000 per day when using a tender, or about half that without a tender. A single month's seatime with about 10 to 20 dives per month (this is weather-dependent) might then amount to $50,000 to $150,000. This might be adequate for some specific jobs such as surveying or monitoring a waste dump, offshore construction, or an artificial reef.

Additional costs would arise from land-based research and development, sea-floor construction, or analysis of the data taken during the dives. In most cases, however, these funds would be obtained from mission-oriented Federal agencies, by contract through research and educational institutions, or from private enterprises.

There are two ways to place the cost of submersibles in perspective. The first is to compare the quality and usefulness of jobs they perform and the information they obtain with that required by more conventional methods. The second is to compare the costs, profits, or ecological risks in the venture for which submersibles are to be used.

For example, a large eastern city might be expected to produce 2,000 tons of waste per day. Disposal cost for this amounts to well over a million dollars per year at a cost of $10 per ton. If this refuse, for example, were volume-reduced into bales, and with some modifications, used for the construction of offshore fishing reefs, the cost of the submersible for assessing ecological impact would be about $1 additional per ton or less. If, in fact, the construction not only failed to produce harm, but had positive economic effects, this would further defray overall disposal costs.

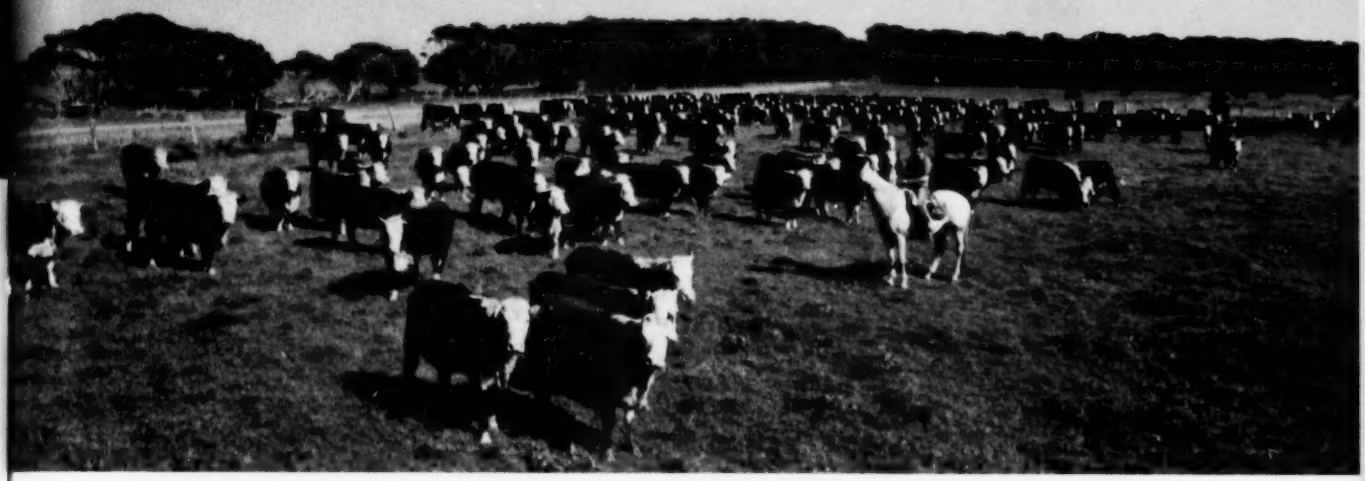
Submersibles could help us cultivate the ocean's resources. In learning how to enhance what the ocean has to offer us with imaginative waste reuse or recycling strategies and in discovering how we can impose our wastes upon the ocean without harming it, submersibles would be invaluable.

What we need for our study of the rates of oxygen utilization by the sea floor and its biota, which I described at the beginning, is a limited-depth, mobile submersible, with an agile manipulator and a moderate cost. This would allow broad surveys without the sacrifice of safety that accompanies SCUBA. It would permit longer bottom times without narcosis or fear of bends. Glass or acrylic spheres would be magnificent for observing the spatial effects of the dumps. Manipulators would be required for maneuvering and controlling ecological experiments and sampling gear.

Submersibles can be invaluable. Dr. Don Swift, a geologist at the National Oceanic & Atmospheric Administration (NOAA), and Dr. Jack Pearce, a biologist, have been using Perry Oceanics *PC8* and the Westinghouse *Deepstar 2000* in New York Bight. Richard Haedrich and I, on the other hand, have been working with Dr. George Keller, also of NOAA, offshore in the Hudson Canyon with our own *Alvin*. This research must continue if we are ever to understand ecological processes on the deep-ocean floor.

The coastal zone will be developed, but its successful management will depend on our understanding of the ecosystem and our technological capabilities to manipulate it. How these two requirements will be met is not wholly clear. SCUBA and habitat-based work will be important, as will conventional surface-ship methods, but these will likely be overshadowed by innovations involving well-engineered submersibles and a suite of mechanical paraphernalia useful in a wide variety of manipulative tasks.■

WASTE INTO WEALTH



"... this unique farm attracts hundreds of people from all parts of Australia and a surprising variety of guests from the outside world."

A mere 22 miles from a metropolis approaching 2½ million population is one of Australia's largest beef cattle ranches, matching in size those normally associated with the wide open spaces of Australia's far and empty North. The city is Melbourne. The ranch is called the Board of Works Farm.

The seeming misnomer comes from the fact that cattle raising is only incidental to the ranch's primary function, which is to serve as the sewage treatment facility for the Melbourne and Metropolitan Board of Works. This is why the Board's major water-borne sewerage system terminates at the farm, where its operations have converted a barren windswept plain of formerly inferior agricultural land into the most productive 42 square miles of grazing land in the whole country.

Just half an hour's drive from the heart of Melbourne the visitor suddenly finds himself in a region of tree-lined country roads and tracks, broad acres of lush pastures and herd after herd of sleek beef cattle. Cowboys (who prefer to be called stockmen) brandish long cracking whips and carry on all the routine activities of a remote ranch, including fencing, corraling, branding and shearing (sheep are carried seasonally). No wonder the visitor finds it so hard to equate this exotic back-country atmosphere with the mundane subject of big city sewerage.

Although the attraction of a sewerage treatment facility is debatable, this unique farm succeeds in attracting hundreds of people from all parts of Australia and a surprising variety of guests from the outside world. A look at the visitor's book reveals several U. S. Congressmen, businessmen from Japan, ranchers from Texas, a TV team from Britain and sewerage design engineers from Malaysia.

The Lucky City

Melbourne is fortunate in that it is one of the few cities in the world with a farm that converts waste into wealth. At the time Melbourne's sewerage system was established in 1893, the population was still small and the land plentiful and cheap. Thus, when James Mansergh, the consulting engineer brought from England 80 years ago, first saw the area he advised the board to opt for a land treatment type of sewerage system and selected a tract on the western side of nearby Port Phillip Bay.

"I cannot help thinking," he wrote in his report, "that in a country where rain is so highly prized, 6,000 acres of land within a few miles of Melbourne and systematically irrigated with something better than rainwater ought to become very valuable."

by S. S. Searle, C.E., M.I.E. Aust., Manager
and C. F. Kirby, B.C.E., M.I.E. Aust., Resident Engineer

Melbourne and Metropolitan Board of Works Farm
Victoria, Australia

This aerial view of Melbourne, capital city of Victoria in Australia, hints at the metropolitan size of the sewerage system required for a city complex of approximately 2 1/2 million people.

In fact, the "something better than rainwater" has produced a rich pastureland. Despite Mansergh's prescience, it is doubtful if he could have envisaged the farm growing over the years to its present size. Nor could he have foreseen the economic importance of its operations in reducing the cost of sewage purification for a highly-industrialized modern city.

The Board's farm is located on the delta of the Werribee River between the State capital city of Melbourne and the large provincial city of Geelong.

The delta was built up with detritus from the basaltic rocks, sandstones and claystones in the watershed when the sea was considerably above its present level. A later fluctuation in sea level exposed the delta, which was then divided by the Werribee River.

In 1891, two years before the farm was established, the area was described as "second-class agricultural land deficient in nitrogen, phosphorus and calcium and tending to be high in chlorides." The depth of alluvium varied from 1 or 2 to 30 feet or more in some places. The soil profile showed about 6 inches of surface brown loam overlying red-brown clay subsoils.

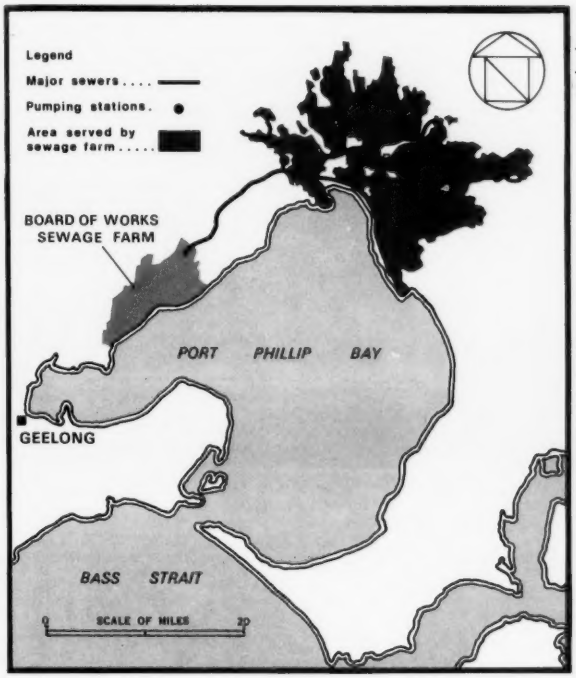
After World War I, the State Rivers and Water Supply Commission established a soldier settlement project on the eastern side of the Werribee River Delta. Using stored river water, this is now a most successful dairy and market-garden area. However, with the entire usable river flow diverted for irrigation, the western half of the delta would still be unproductive if it were not for the use made of Melbourne's wastewater.

With the constantly increasing wastewater flow from the city over the years, the area of the farm has been enlarged from 8,847 acres in 1893 to the present 26,809 acres. Of the present acres 10,376 are irrigated for permanent pasture (providing a land filtration process for the waste water), 3,472 are graded and sown down with Italian rye grass for winter grass filtration (providing areas of overland flow for the wastewater) and another 3,393 acres of low lying foreshore are occupied by oxidation lagoons. About 7,000 acres are reserved for dry grazing of livestock while the remainder is taken up with roads, plantations and foreshore reservations.

Land for irrigation is sown with a mixture of grasses to provide a balanced pasture throughout the year: perennial rye, Italian rye, white clover, strawberry clover, alsike clover, cocksfoot, timothy and meadow fescue. The pastures require little attention apart from regular irrigation, and repairs are needed only where pasture land has been damaged by heavy stock traffic, such as at drinking troughs and gateways.

Wastewater Effects on the Soil

The raw wastewater applied to the pastures is "strong." It has an organic content of 0.06 percent by weight and a mineral content of 0.10 percent by weight — some in suspension and some in solution. Suspended material is filtered out by the soil and transformed into humus and plant food by the action of soil micro-organisms. A generous supply of nitrogen, phosphorus, potash,



The Melbourne and Metropolitan Board of Works sewerage farm is located on the western half of the Werribee River Delta from where purified effluent will eventually flow into nearby Port Phillip Bay.

A waterman cleans out brush interfering with operation of this spillway outlet at one of the sewerage farm lagoons.

calcium and trace elements in the wastewater promotes plant growth. The sodium chloride content is about 650 parts per million (ppm). But there have been no soil salinity problems because the more soluble elements or salts continue to travel through the permeable soil until removed by the drainage system.

Domestic wastes, industrial wastes and ground-water infiltration into the sewers account for the total flow, with industrial wastewater providing about half the biochemical oxygen demand and suspended solids. Trade wastes are controlled to avoid the introduction of toxic substances in concentrations likely to be harmful to the sewers, pastures or livestock.

Irrigation Offsets Evaporation

Since the farm is in quite a dry area, irrigation usually extends over 6 or 7 months of the year. During this period, 10 or 11 waterings are applied at intervals of 3 weeks, each application being about 4 inches deep. This maintains the soil in a healthy aerobic condition and, in turn, produces excellent pasture for the grazing of stock. The rainfall ranges from 1 1/2 to 2 inches a month throughout the year, the annual average being less than 20 inches. Allied to this low rainfall is a high evaporation, which rises to more than 7 inches a month in the summer irrigation period.

The grazing livestock are removed before irrigation takes place and the surface is allowed to dry out before they are returned. The drying-out period is about a week, leaving 1 1/2 to 2 weeks for grazing before the next watering. The number of animals used in this rotational grazing is, of course, determined by the amount of pasture to be eaten off before the next irrigation is due.

During the peak of the irrigation season, water is applied to pastures at the rate of 220 acre-feet a day. (This amounts to approximately 2 inches per acre per week.) In a typical summer, the total quantity used for grass production would be about 34,000 acre-feet, or about one-fifth of the total wastewater received on the farm in the year.*

The irrigation is continuously controlled by about 100 shift workers who handle the flow as it is received, the daily peak and storm flows being diverted to lagoons. During the drier summer irrigation period, about half of the widely fluctuating daily flow is used on the land. The balance of the wastewater not required for irrigation is purified by primary sedimentation and oxidation in shallow ponds. During the winter the whole flow is treated by sedimentation followed by grass filtration and oxidation ponds.

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*The original concept was to treat all of the wastewater either by land or grass filtration, with the peak flows diverted to oxidation ponds for treatment. However, Melbourne's metropolitan growth eventually overloaded the acreage available for this purpose. Thus, today more than half the annual supply is regularly treated in the oxidation ponds. Since it cannot readily expand farm acreage sufficiently to alleviate overloading, the Board of Works has begun construction of a small conventional secondary treatment plant. Also, renewed consideration is being given the implementation of a 1930 vintage plan. This plan calls for pretreating the wastewater before applying it to the land. Once the pretreatment system is in operation and a proper sludge handling process is developed, the odor of raw sewage will be removed. At that point the farm's land treatment system will approach the types being planned by the U. S. Army Corps of Engineers in its Urban Studies Program — intended to coordinate urban water problems with other municipal considerations.

About 26 miles southwest and only a half hour's drive away from Melbourne is its vast Board of Works sewerage farm at Werribee. The farm's wide ranging 26,809 acres stretch beyond the limits of the viewer's eyesight.

One of the many regulating channels used to distribute effluent throughout the farm.

After irrigation, soils show a marked increase in nitrogen, phosphoric acid and potash, while lime remains fairly steady and the salt content decreases. The top soil is high in humus and permeability remains good after the long period under irrigation.

Preliminary to the establishment of the sewerage system in 1897, the farm was laid out for irrigation with channels, drains and roads on a rectangular grid, creating paddocks of a standard size of 20 acres. Then the land was deep-plowed to a depth of 30 inches to break up the less permeable soil.

Within each paddock, a series of small straight channels feed into level grassed surface bays. Each bay is 2/5 acre in extent and surrounded by low check banks to permit a heavy application of water without run-off. In some irregular areas, contour channels are used. However, those areas developed since 1930 on this border-check system are watered by conventional flood-irrigation methods.

Channels are generally built above ground level in well-compacted banks, so that nearby areas can be watered with a minimum check in the flow. This also avoids deposition of suspended material.

In the original construction the main channels were of concrete and they are still operating in reasonable condition. But the cast iron half-round-section flumes used as lateral distributors proved to have too little freeboard. Consequently, small displacements due to settlement or other causes led to overtopping and most have been replaced by earth or concrete-lined trapezoidal-section channels.

The smaller distribution channels are constructed out of earth. Many of the larger channels were also con-

A waterman irrigates pastureland on the farm.

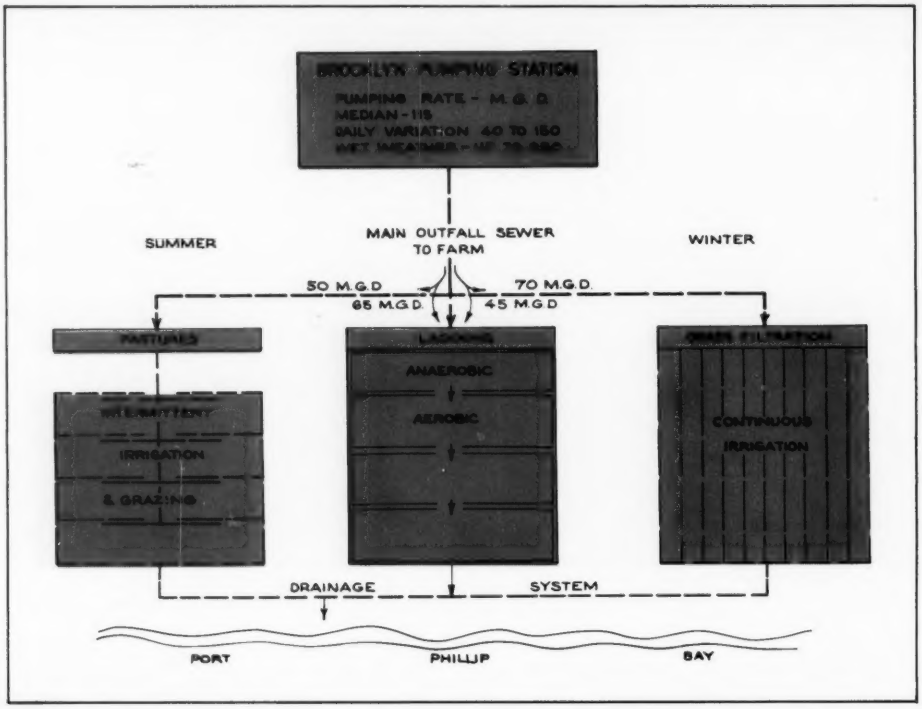
This photo, a prized possession of the authors, shows the typical steam traction engine and plow used for sowing pasture in the early days of the sewerage farm near Werribee.

structed out of earth, but as the farm expanded, most of these, as well as all new channels constructed during the past 20 years, have now been lined with 2 inches of unreinforced concrete. This is to improve hydraulic conditions, prevent weed growth and deter burrowing rodents. Channel banks above the concrete linings are treated with soil sterilants to keep them clear of weeds, while weed growth in the small earthen channels is kept in check by mechanical cutters.

The adoption of standard channel sizes permits linings to be applied by means of a moving concrete-filled form towed by winch along the prepared earth subgrade. There is now a total of 520 miles of channel; and 153 miles of the larger and more important ones are concrete lined.

Open drains or ditches 4 to 5 feet deep extend throughout the irrigation area. Their function is to collect and feed groundwater seepage into the four outlets that carry water into Port Phillip Bay. They also prevent a buildup of salts in the soil. Their low banks prevent direct entry of irrigation water into any drains. The underground agricultural drains laid in some pasture areas to facilitate drainage were subsequently blocked off because the cracking in the clay soils allowed wastewater to discharge too rapidly into these drains without adequate purification through land filtration.

All drains are inspected daily and control samples are taken twice weekly for laboratory examination. This ensures that the prescribed standard of less than 30 ppm of suspended solids and 20 ppm of biochemical oxygen demand is not exceeded in water discharged to the Bay. Results of analyses by the local control laboratory are



Irrigation is continuously controlled according to the needs of the wet and dry seasons.

A stockman drafting fat bullocks for market.

available 24 hours after sampling in the field. A very complete examination of all drainage waters is made monthly by the Board's chief chemist at the central laboratory and his report becomes the comprehensive record of operating performance. Test holes drilled in 1891 showed the water table at depths varying from 6 feet to 18 inches below the surface. Regular observations since show that the average levels have not changed; rises which follow irrigation fall away fairly rapidly.

Odor Not Serious Problem

The proximity of such a large area of sewage treatment land (which uses essentially raw sewage) to two large centers of population suggests an odor problem; and, from time to time, allegations have been made of odors reaching the city of Geelong 10 miles southeast of the farm.

As a result, a Committee of Inquiry appointed by the State Government conducted a searching investigation over a representative period. Many inspection visits were made to the Werribee and Geelong districts following local complaints. Results of these visits were combined with the results of liaison with the Bureau of Meteorology and scientific data obtained by a consultant laboratory. All led to the now accepted conclusion that odors experienced in Geelong and vicinity do not come from the farm but, almost without exception, emanate from local sources.

On one occasion only, the test indicated that the volatile compounds of the air at the Geelong Harbour Trust Building were similar to those in the air sampled in a section of the farm. While on rare occasions weather conditions may cause odors to drift in a southwesterly direction towards Geelong, prevailing winds far more often cause a northeasterly drift. Yet, even under these prevailing winds, odors from the farm are detected only at nearby Werribee for brief periods, and never at other towns to the northeast of the farm.

The Board of Inquiry concluded, therefore, that there was nothing to support the claim that odors from the Werribee Farm frequently permeate the Geelong area.

In short, the odor problem was considered negligible by the Board of Inquiry. Its report concluded that complete elimination of odor was impracticable because "the present method of treatment and disposal of sewage at the farm (irrigating with essentially raw sewage) could be modified to substantially reduce any odors emitted therefrom only at enormous cost."

Self-Reproducing Mowers

The efficient disposal of wastewater by soil filtration depends on the grasses being kept short, which is how the role of livestock (both cattle and sheep) as grass mowers began. To this end — and to ensure continuity of supplies for the profitable beef-marketing program — a 10,000 cow breeding herd is carried on the farm. Including the necessary bulls, young steers and heifers,

there are up to 20,000 head of cattle on the farm. Angus and Hereford breeds predominate, but the farm also carries limited crossbred Charolais and Friesian cattle which are being used on an experimental basis.

Since 1910, the farm has operated as a commercial beef enterprise, producing 20-22 month old steers and fattened cull cows and heifers for the Melbourne market. During the past 62 years, more than 270,000 cattle and more than 1 1/2 million fattened sheep have been marketed.

The "Beef Measles" Bogey

In the early 1930s, these cattle sales were abruptly prohibited because of an incidence of *Cysticercus bovis* (commonly known as "beef measles"); but under pressure of informed opinion, the Victoria State Government passed legislation enabling the Board to continue selling its cattle for human consumption — provided that they were slaughtered immediately after sale at an abbatoir in the Melbourne metropolitan area and that the carcasses were properly inspected and branded.

Since the Board was prohibited from selling cattle for breeding, it resorted to the practice of buying cattle and fattening them for sale. This practice was discontinued in 1946. From then on practically the whole output of fattened cattle has been bred and raised right on the farm. The few exceptions are the bulls and females bought for breeding purposes and then sold after being on the farm for several years.

By virtue of the farm's breeding of its own stock, its cattle have built up an immunity which makes market rejection because of cysticercosis extremely unlikely. Between July 1946 and June 1972, the breeding policy was fully implemented and out of a total of 116,266 beasts marketed, there were only 29 rejections — or 0.025 percent. (A report covering the June-December 1966 period indicates a rejection rate of 0.041 percent for all the cattle slaughtered in Victoria and Tasmania based on examination of 506,625 animals and 208 rejections.)

Animal Husbandry

Beginning each August (midwinter), 15-month-old breeding bulls selected from the previous year's calves are joined to similar age heifers; but only heifers exceeding 500 pounds liveweight are mated.

The joining period is limited to 3 months, after which pregnancy testing of the 10,000 breeding cows determines which of them are not in calf and may be drafted (selected) for sale.

New calves are left with their dams until they are weaned in midsummer. After weaning, the steers are segregated, put on selected pastures and given special attention to ensure maximum growth before being marketed the following autumn.

Meanwhile, about 500 young bulls are selected for next year's breeding at the November (early summer) calf marking. Breeding bulls are selected on soundness, conformation and their ability to gain weight. This is determined by weighing the bulls at weaning and again at about 14 months, just prior to their selection for breeding.

Since there is little pasture growth during winter, it is necessary to feed the cattle with grass hay produced on the farm in the summer. All cattle are hay fed for about 4 months. Cows susceptible to grass tetany are fed magnesium-treated hay.

Sheep — mainly crossbred wethers — are brought in and fattened on the farm for 3 to 6 months each year, the number depending on the nature of the season and what surplus grazing is available after the needs of the cattle have been met.

The farm at one time carried as many as 72,000 sheep, but, considering the uncertain sheep market and the greater profitability of cattle, the number of sheep grazed will now be limited to 10,000.

Trained stockmen, some of whom are assigned responsibility for particular farm areas, are employed permanently to tend the cattle and sheep. Another small but expert group of stockmen does routine yard work such as calf marking, pregnancy testing, drafting for market and selecting for calving down (breeding). Their stock horses, like cattle, are bred and schooled on the farm.

Fresh water from the Board's mains, which is reticulated throughout the farm for employees and their families, also provides drinking water for the livestock.

Four Birds with One Stone

The Werribee Farm of the Melbourne and Metropolitan Board of Works is thus a highly productive, intensive livestock enterprise as well as an efficient wastewater treatment project. New technological developments and improved management methods are endlessly being adopted and adapted so that productivity and standards of efficiency continue to grow.

The net returns from the farm's marketing operations (over $500,000 per annum) are offset against the costs of sewage purification and thus significantly reduce the costs of this service. As a result, the annual per capita cost of sewage treatment amounts to $1.07. (Both amounts are stated in Australian currency in which each dollar is the equivalent of $1.20 U.S.) Thus, the farm plays an important and productive part in the city's wastewater disposal system, with the potential for further development as an important community-owned asset.

Besides its value in purifying municipal wastes, partially paid for through beef cattle sales, the Board of Works Farm provides a wildlife sanctuary. Beyond these more obvious values, the vastness of its nearby open space, situated between the Melbourne metropolitan and Geelong municipal areas, is insurance against urban sprawl in that direction. All of these benefits add up to "*four* birds with one stone." ■

Operation Noah II

Tropical Storm Agnes Triggers Unprecedented Recovery Effort

by Mary Ann Striffler

For many people, the big flood of late June 1972 is just a memory of some minor inconvenience such as a traffic detour or a vague recollection of a series of weather reports. But for others, Tropical Storm Agnes is still all too real.

Devastation was so extensive that the President declared the entire State of Pennsylvania, the southern tier and fingerlake area of New York, a large portion of Virginia, a portion of West Virginia, a good deal of Maryland, six counties in Ohio and the Gulf coastal area of Florida to be disaster areas. In addition, parts of Delaware and North Carolina were damaged.

A look at Agnes, the destruction she caused and the recovery mobilization she triggered shows why this flood is unprecedented in the United States. Within the time span of a few days, Agnes swept into Eastern United States temperamentally dying down and then flaring up again as she continued her general northeasterly course. While a "normal" storm of her type would have been expected to go out to sea in the vicinity of Cape Cod, Agnes headed seaward near Maryland and then suddenly turned back to the west finally to dissipate inland. Rather than having an "eye" that could be pinpointed, Agnes had a center of 200-400 miles of solid clouds and rain. Agnes even reversed standard flooding patterns in some areas. As the storm moved upstream, some rivers reached their highest levels in the *lower* basins before they crested in the upper basins.

The Susquehanna River Basin was one of the areas hardest hit as Agnes moved northward. The five days of evolving disaster there served as the forerunner to the largest-scale recovery program that the Corps has ever been assigned.

June 20. Rain is starting in the Susquehanna River Basin. In the James River Basin, rains are decreasing as weather forecasters turn their attention to the Potomac and Susquehanna. Ola D. White is the hydrologist in charge of a staff of eight other hydrologists and one secretary at the National Weather Service River Forecast Center in Harrisburg, Pa.

Miss Striffler, Ohio University senior majoring in journalism, worked as a summer intern on the *WATER SPECTRUM* staff.

The waters receded . . . devastation was left.

June 21. As the morning dawns, rain becomes a heavy downpour. Almost six inches have fallen in Alfred, N.Y., a town located on a small tributary in the Chemung watershed. NOAA's National Weather Service's Binghamton River District Office issues a flash flood warning at 9:30 a.m. The people in Elmira, N.Y., hear this general warning and three more that day. Binghamton also issues forecasts on the stage of the river for Elmira and for Corning, N.Y., both located on the Chemung River, part of the Susquehanna River Basin.

June 22. Heavy rains continue on into the evening. At Corning, the Chemung passes its flood stage of 16 feet at noon. Also at noon Radio Station WCLI receives a flash flood watch on the Associated Press wire. It broadcasts the flood watch every half hour.

At Harrisburg, the Susquehanna reaches a flood stage of 17 feet at 2 p.m. By now, many of the river gauges are washed out and White and his crew must rely on estimates. It is impossible to collect data from many of the rainfall gauges.

Elmira receives two more flash flood warnings.

At 9:30 p.m. the Susquehanna River passes flood stage of 22 feet at Wilkes-Barre, Pa.

June 23. Rains have dwindled in some areas, but in northern portions of the Susquehanna Basin the rains still pour for another 48 hours. At 2:50 a.m. a retired general, Frank T. Townend, director of the Luzerne

County Civil Defense, receives a forecast that the river will reach 40 feet in the Wilkes-Barre area. At this "incredible" forecast, Dr. Richard Gerstell, State director of Civil Defense in Harrisburg confers with hydrologist Michael Gwinner before ordering 80,000 people in the flood plain to evacuate their homes.

At 7:15 a.m. electric power at the forecast center in Harrisburg is knocked out. A substation has flooded. The hydrologists continue to work without power, using manual forecasting procedures. Their computer is inoperable. The phone is malfunctioning and the hydrologists can only call out. No one can call in.

The levee in the Wilkes-Barre area breaks at 3 p.m. The Chemung crests at 36 feet at 7 p.m. at Corning. It crests at about 25 feet at 11 p.m. at Elmira.

Hydrologists work on into the night at Harrisburg using the light of one lantern.

June 24. The Susquehanna crests at 32 1/2 feet at noon at Harrisburg and 40 1/2 feet at 6:15 p.m. at Wilkes-Barre.

That was the work at the weather stations and thus the people learned about the ominous presence of Agnes. Most people responded well to emergency procedures and the loss of many lives was prevented in spite of heavy flooding.

The waters receded and the statistics and devastation were left.

In her wake, Agnes left 118 dead and caused the evacuation of over 350,000 people from their homes. Total damage to public property was estimated at $744 million and damage to private property was estimated at $2.8 billion. Beyond estimation, however, is the amount of sorrow and heartbreak caused by irreplaceable losses.

In Agnes recovery operations, the Army Corps of Engineers has been working with many Federal, State and local agencies and private interests. Under the name "Operation Noah II," the Corps began its disaster recovery mission and the Director of Civil Works, Maj. Gen. J. W. Morris, devoted full time to mobilizing the Corps' part of the effort.

The Office of Emergency Preparedness (OEP) assigned the following responsibilities to all the Corps districts in the flood disaster areas:

- making detailed damage surveys to estimate cost of repair.
- surveying additional counties to determine if they qualify as disaster areas.
- removing debris from public and private property, roads, bridges, stream banks and channels.
- rehabilitating water and sewage systems and plants (except in New York where the Environmental Protection Agency has that duty).
- restoring electrical power.
- repairing and rehabilitating public buildings.
- repairing dikes not covered under Corps authority.
- administering those contracts of less than $50,000 which were let by New York and Pennsylvania State and local entities. (These contracts differ from usual Corps contracts which are let by the Corps itself. The Corps is offering technical assistance, making interim and final inspections, auditing and making reimbursements.)

Corps responsibility also calls for emergency and permanent repair of flood control structures under its statutory authority. Work in this category will cost an estimated $17.5 million.

OEP estimated total cost for debris removal will come to $85 million and repairs of streets, roads and bridges will amount to $237 million. Costs for dikes, levees, irrigation and drainage repair will be an estimated $59 million. The Corps is administering a large portion of this work.

When the Corps emergency teams go to work, civilian and military personnel from all over the country stand by to help in case the disaster is beyond the handling capability of any one division or district. The Office of the Chief of Engineers, as well as each division or district in the affected area, manages an emergency operations center. The one in Washington began functioning on a 24-hour basis on June 23.

In the case of Agnes, the North Atlantic Division needed aid from other Corps districts and divisions. By June 26 its New York, Philadelphia and Baltimore Districts had called for 292 civilian personnel. Assignments were handed out by June 27, and 174 reported immediately from Corps offices across the country. The other 118 civilian personnel stood ready for the word to move.

Military personnel moved in at the same time. By June 23, General Morris had sent out word that additional civilian and military personnel would be needed.

On the morning of Saturday June 24, the first day that the heavy cloud cover lifted and damage could be seen from the air, Lt. Gen. F. J. Clarke, Chief of Engineers, made an aerial survey of the disaster area. He estimated that about 100 company grade (lieutenants and captains) and 15 to 20 field grade (majors and colonels) officers would be required. On that same day, officers from various districts and divisions were already on their way to report for temporary duty in the disaster area. Many were briefed by General Morris at Fort Belvoir, Va., on Sunday and then went directly to the disaster area.

On July 14, the North Atlantic Division Engineer, Maj. Gen. Richard H. Groves, formed a temporary Corps district, the Susquehanna District, to handle flood recovery work. Col. John F. McElhenny was assigned the job of heading up the new unit, staffing it with Corps personnel from across the Nation.

The Susquehanna District is finishing the immediate mission of debris removal, water and sewage systems repair, and repair to public buildings, and has begun helping with the construction of mobile home sites for temporary housing and the temporary repair of private homes. The housing work represents a new activity for the Corps.

Coverage of rehabilitation work, still going on in the Susquehanna and other river basins, is scheduled for the next issue of *Water Spectrum.*■

UNBEATEN GRADUATES
Enter Water Resources Arena

by Benjamin C. Dysart III

The author discusses yesteryear's "beat to fit and paint to match" educational process, and applauds some of today's new graduate programs for preparing water resources engineers to meet tomorrow's job requirements.

What may be expected from today's water resources engineering graduates? Many significant changes have taken place in both water resources practice and education in recent years. At the very beginning, I would like to emphasize that there are no *typical* water resources engineers; they are encountered in many different forms with vastly differing orientations, perspectives, and academic backgrounds. I will, however, comment on what you *can* and *should expect* today's graduate — *tomorrow's* water resources engineer — to be like.

To answer the original question, it is necessary to address some basic questions regarding the man himself, the academic process that prepares him, and recent developments in the water resources field. Included might be questions such as: Should all engineers who graduate in water-related disciplines be termed water resources engineers? What changes have taken place in the academic preparation of water resources engineers? Are these "new" graduates really different from the engineering graduates of a decade ago who are doing water resources work today? Can these "new" graduates do better work for their employer than the "old" graduates and other engineers being prepared today? What are the goals and motivations of tomorrow's water resources engineers? What do they hope to accomplish?

Perhaps the matter of what to expect from today's water resources engineering graduate can be put into perspective by comparing and contrasting him to engineers trained in water-related specialties of ten years ago. Even today there is no real consensus as to what exactly constitutes or should constitute a "Water Resources Engineering" program.

I have been actively involved in water resources during this past decade of development and maturing of water resources education, and I have discussed this general subject with colleagues who are and have been at the forefront of innovative water resources education. Also, I discussed my topic with a number of our water resources engineering and environmental systems engineering graduate students at Clemson University. These students are from all across the Nation and have undergraduate backgrounds in various branches of engineering and science.

As a result of the inputs from other faculty and the students themselves, I feel that my subsequent comments and interpretations are representative of what might be expected from graduates of progressive water resources engineering programs today.

Changing Educational Process

Before examining the objectives and motivations of the students, let's review some of the background on the educational process as it relates to water resources engineering needs. A truly interdiciplinary area such as water resources engineering cannot really exist or be recognized at the undergraduate level. It is now generally agreed that some sort of study beyond the four-year bachelor's program is necessary for the practice of professional engineering. This is the case today in

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Today's students become acquainted with the use of computer graphic equipment. Here, a computer technologist demonstrates use of the light pen to change input parameters for a river basin water quality model.

certain areas such as sanitary engineering and will probable be true for many other areas of engineering in the near future. The rapidly increasing emphasis on the professionally oriented master's degree is ample evidence of this. *If a four-year program cannot adequately prepare an individual for practice in a reasonably well defined technical specialty area, then it can hardly be expected to do more than provide a good foundation for interdisciplinary area such as water resources engineering.*

Over ten years ago, I gained some very valuable insight into engineering education from an ironworker while on one of my first construction projects as a newly graduated engineer in industry. I realized that my fabrication drawings were in error and brought this to the attention of the ironworker foreman. He pointed out to me that his men had big sledge hammers and could, when faced with almost any problem, "beat to fit and paint to match." I was somewhat relieved and, at the same time, thankful that well-trained engineers did not adopt such simplistic approaches to problems.

The passage of a few years, a little more perspective, and involvement with engineering education, specifically environmental and water resources engineering, have made me realize that the ironworker's comment characterized most engineering education at that time and, maybe more than we would care to admit even now. Engineering education was, for the most part, preparing individuals for a specific technical function in industry, consulting, or government service. Most engineers at the bachelor's level entering the profession were prepared by the universities to "keep the wheels of industry turning" and little else. The engineering students were, in essence, being *beaten to fit* into a well-defined ubiquitous role. They were not nearly so much concerned with the implications of their technology for society as for doing as good a job as possible in designing, building, or operating some sort of engineering work. Quite frankly, most were neither asked nor expected to do more.

Then the employer finished the engineer's preparation for his early technical career by a combination of on-the-job experience, training, and orientation. Finally, the individual had been *painted to match* the specific slot or function desired for him. Perhaps the ironworker being directed by the engineer had more insight into what had been taking place than the engineer himself.

This sort of role is still important for many engineering graduates, *but to some will fall much broader and greater responsibilities as well — responsibilities such as considering how the technical aspects fit in with currently accepted and evolving goals and needs of society.* Tomorrow's water resources engineers are among those in this latter category.

Many so-called "water resources engineering" graduate programs a few years ago were simply good solid hydraulics, hydrology, or civil engineering programs. Some programs today are basically the same as those several years ago but with a new name. This has been the easiest way to get a water resources engineering program going and seems to be yet another variation on the ever-present and popular *beat to fit and paint to match* theme.

Practically all water resources engineering programs, however, have elected to pursue the interdisciplinary approach to varying degrees. Some simply tack on an economics, systems, or planning course or possibly even two or three such courses and turn out a somewhat reoriented hydraulic engineer, hydrologist, or civil engineer. This is particularly the case when only the traditional "water" faculty within engineering teach all or practically all of the courses. The program is improved if these broadening or supporting courses are obtained outside of engineering where possible and appropriate.

The commitment to the interdisciplinary approach ranges from sheer tokenism to really active involvement of both engineering and non-engineering faculty in the conduct of the program. Some programs are highly structured with little or no latitude as to orientation and electives. Others are a potpourri of courses from all over the campus that may or may not be woven into a coherent program of study by or for the student. Neither extreme is desirable for or conducive to producing tomorrow's water resources engineer.

There is and will continue to be a need for competent technical specialists in the water resources area including hydraulic engineers, hydrodynamicists, civil

engineers, hydrologists, and many others. However, there are probably enough specialists being produced each year in these important areas by our present educational system to meet current and anticipated needs in the water resources area. The shortage today is in *Water Resources Engineers.* These engineers trained to meet tomorrow's demands have a sound technical background and can clearly identify with one of the more traditional disciplines mentioned earlier, but they also have a good understanding of the larger scope of water resources — an overall or "big picture" view if you will. Tomorrow's water resources engineer, if he chooses to confine his master's program to the normal period of time, will not have the same depth in a relatively narrow area as the technical specialist. Nor will he have only a couple of graduate courses in each of half a dozen assorted areas. *Tomorrow's water resources engineer should not be confused with either the technical specialist or the generalist. The "new" water resources engineer has been carefully prepared to complement the technical specialists in the water resources area, not to replace them.*

It should be emphasized that not all water resources programs are engineering programs. Even in an engineering program, the importance of non-engineering faculty and coursework must not be minimized. Most of the problems regarding water resources planning, development, and management today have their real roots in nontechnical or non-engineering areas. Engineers in traditional water-oriented areas have tended to have their strength in technical areas and have lacked adequate training in the economic, social, legal, institutional, political, and ecological interaction areas.

At Clemson University, we have been able to implement a water resources engineering graduate program that appears to provide a well-balanced approach for training the "new" water resources engineer. A truly interdisciplinary theme is assured through the water resources engineering core faculty and the flexible core curriculum requirements. The fifteen-man core faculty now consists of eight representatives from the College of Engineering and seven from six other colleges across the university. The specialty areas of the present core faculty members are: biology and fisheries, economics, environmental engineering, geology, hydraulics, hydrology, ocean and coastal engineering, political science and public administration, recreation, regional planning, and systems engineering.

All of these fifteen individuals are *actively involved* in the water resources engineering program on a *continuing basis.* They present courses usually or frequently taken by water resources engineering students, serve on the students' advisory committees, and conduct ongoing sponsored research in the broadly-defined water resources area. The members of the core faculty average serving in two of these three capacities. The composition is adjusted annually to assure the availability of the most currently active faculty members in the entire water resources area.

Unlike more conventional water resources graduate programs based in engineering, the core curriculum for Clemson's water resources engineering program is specified by areas instead of specific courses. A minimum of two approved courses is required in each of the following areas: (a) water quality and environmental aspects, (b) water occurrence and transport, and (c) policy and planning. There are about five approved courses for each core requirement area. When the core requirements are satisfied, the student is free to structure the remainder of his program of study, with the advice and approval of his committee, to obtain a degree of depth in the technical emphasis area of his choice such as, water resources planning and management, ocean and coastal engineering, or surface water systems.

Typically, the water resources engineering student takes a third to a half of his coursework outside of engineering. The result is that he has significant contact with both faculty and students in important disciplines such as economics, planning, and geology. The insights gained by working and studying with non-engineers in their own environment are extremely beneficial for future interdisciplinary team efforts.

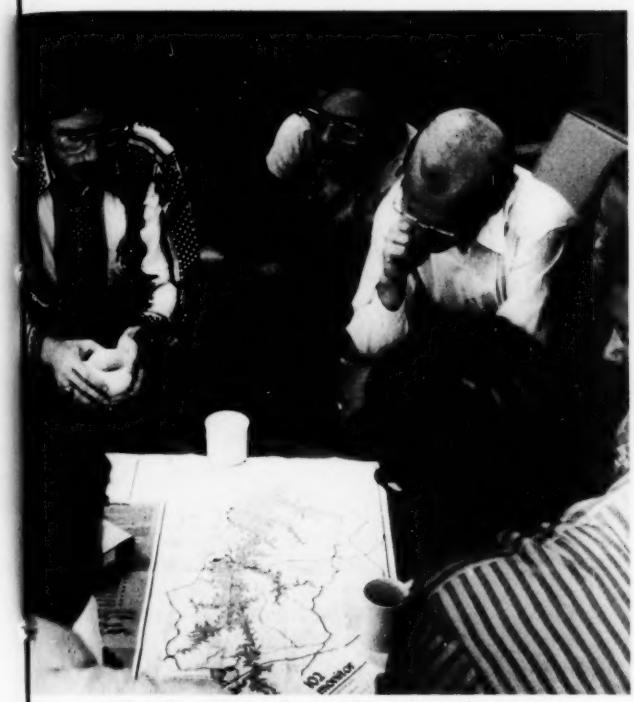
Tomorrow's water resources engineers being prepared today at Clemson and elsewhere along the lines discussed will certainly have a different background than that which water-oriented technical specialists are receiving or that which engineers working in the water resources field today received. With the great changes in the public's goals that have taken place recently and are continuing to take place, as well as the increasing complexity of water resources systems, it is obvious that some new, fresh approaches will be needed. The new graduate can provide the necessary know-how to help, along with water-oriented specialists, achieve such goals through the mission or responsibilities of the firm or agency for whom he works.

Today's water resources engineering graduates have much to offer the profession, their employer, and society. They can help resolve some of our most pressing problems relative to the development and wise use of our water resources. To disregard the ideas they can bring to the water resources area or to give less than adequate consideration to their suggestions could well advance the notion that much water resources development is conceived and implemented in a more or less conventional manner during these dynamic times. This must not and, furthermore, *need not* be the case.

Specific Attributes

The discussion to this point has been necessary to answer the first three of the six questions originally posed relating to what the "new" *Water Resources Engineer* is and the educational process that prepares him. A fuller appreciation for what may be expected from today's water resources engineering graduates should result.

Subsequent comments and observations will represent a composite of recent water resources engineering graduates and those approaching this point in their career. It is hoped that these remarks will be useful in understanding these individuals and may also result in better utilization of their talents.



At this "classroom-in-the-round," students discuss an environmental impact statement on a proposed nuclear power plant being constructed on a reservoir.

Today's water resources engineering graduates are much more consciously dedicated to the accomplishment of socially worthwhile, long-range goals than their predecessors of ten years ago who were more technically oriented and somewhat more specialized. A number of today's graduates find their area is a calling of sorts. Some have given up attractive and responsible technical positions to enter the water resources area. They are less concerned with the physical engineering work, like dams or highways, as acceptable ends in and of themselves than the results or effects such works actually bring about.

They have a better feel for and appreciation of the natural resources they are to work with than the engineers before them. They have people- and resource-orientation in addition to the usual orientation toward the technology itself. These recent graduates have seen the supply of some natural resources dwindle to the point where the end could well be in sight. They feel that the time-tested approaches which were adequate in the past when most resources were considered to be essentially unlimited need to be improved upon now. They are very aware that our water and related resources are indeed finite and must be effectively planned and managed to benefit man on a sustained basis. As a result of these feelings, they encourage public participation in water resources decision making.

Today's water resources engineering graduates see the increasing emphasis on system effectiveness, efficiency, and reliability as being a positive and logical development. The methodology at their command can help address such matters when traditional techniques might well be inadequate. Their undergraduate education has provided them with a better background in the underlying principles and theory of engineering phenomena than was provided a decade ago. They are better able to apply these principles to new situations than if they had received "how to do it" or "handbook" training which was rather common then.

Water resources engineering graduates have varying degrees of expertise in the systems and computation areas. They can use and effectively work and communicate with specialists in the important areas of mathematical modeling, optimization, simulation, and sensitivity analysis. They are also very aware of each technique's limitations as well as its utility. The tools they use are viewed as aids to good engineering judgment and not as a panacea. They know that difficulties can result from not using currently available techniques. But they avoid the pitfalls of assuming that results from such studies and analyses are inviolate.

They also have some background in natural resources and welfare economics as well as traditional engineering economy. Today's graduates are familiar with the systems hierarchy which exists in so many water resources projects. They do not necessarily limit their consideration to their immediate system level but consider how it relates to both larger and smaller scale systems. They are aware of multiple objectives which frequently are conflicting, the wide assortment of components that can be used to achieve various project objectives, the complexity of modern water resources systems, and other factors that not only make it desirable but *imperative* to consider a wide and comprehensive range of alternatives, structural and non-structural. This type of evaluation is impossible to do adequately without the systems tools they have available or are familiar with.

The water resources engineering graduates of today are more concerned about environmental and ecological matters than were the water-oriented engineers of ten years ago. Probably more important, they are more *knowledgeable* in the environmental area than their predecessors. They are less likely to discount cautions regarding excessive use or alteration of natural resources than the engineers of previous years. Nor, on

the other hand, do they rely upon self-appointed prophets of doom to do their thinking for them. They can reason things out in this area and can separate environmental fact from fantasy. They are familiar, at least to some extent, with the latest techniques for controlling water pollution and have a feel for the costs and the benefits involved.

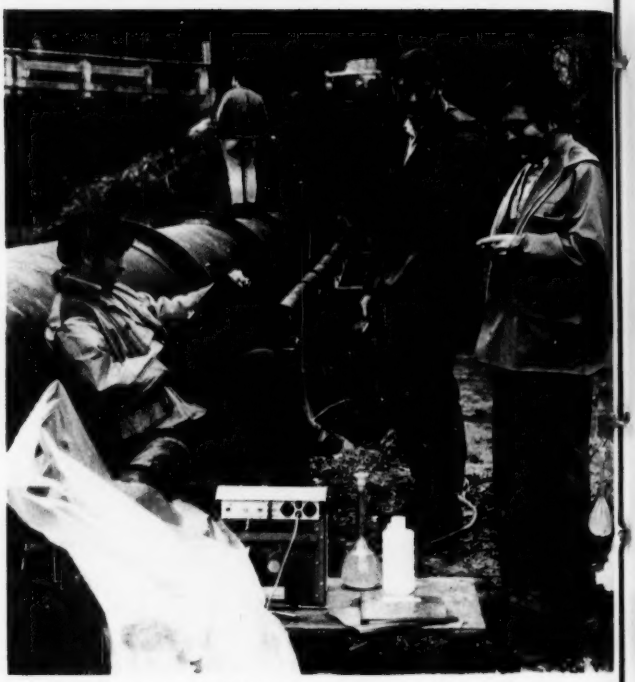
They are aware of the dynamic and evolutionary nature of the overall objectives of water resources development. They have studied the changes that have taken place in goals and objectives in our Nation in the past in context with present changes and those developments which loom on the horizon. They have studied the National Environmental Policy Act of 1969 as well as the Water Resources Council's new principles and standards for evaluating water resources projects and are aware of the officially proclaimed desire to "enhance the quality of the environment." They are less likely to become committed to existing objectives to the extent that it would be difficult to respond when objectives change.

Today's water resources engineering graduates are either aware of or products of the marked changes which have taken place in engineering education in recent years and the rapidly changing role of the professional engineer. They prefer to conceive and design systems, large and small, rather than carry out routine "nut and bolts" tasks that are increasingly being handled by competent and well-trained engineering technologists and technicians who are prepared to do the work that many engineers were trained to do ten years ago. The "new" water resources engineer feels that he can make contributions that will be of equal or more benefit than either detailed design by specialized professionals or the routine matters performed by technicians.

In general, today's water resources engineering graduates have little inclination toward long stints at the drafting table, sizing pipes, or running desk calculators. Progressive water resources engineering programs are not really preparing their graduates to serve as "apprentices" for several years as used to be both common and accepted in the engineering profession. Employers who make full use of their engineers' abilities as soon as possible should encounter no difficulties on this count.

The water resources engineer graduating today is prepared to work effectively in interdisciplinary team efforts toward the solution of water resources problems and the accomplishment of project designs. He has had good exposure to the team approach of considering complex problems and knows how to work with various types of engineers as well as non-engineers and to respect their ideas and perspectives. He can communicate with professionals in his own and related disciplines and see how the contributions of each fit together for a more complete and adequate coverage of the problem.

Today's graduates have a good appreciation for the interrelationships which exist between technological matters and economic, social, legal, political, and institutional aspects. They know that these interrelationships are very real, though sometimes subtle and extremely complex. They are aware that, in many cases, these factors dictate what is feasible and practical more than the comparatively straightforward technical matters.



These students are at a field location to conduct an experiment in monitoring the flow of effluent.

When not engaged in projects or activities that specifically call upon their interdisciplinary skills, tomorrow's water resources engineers can function adequately in their technical emphasis area. It should be noted that, in addition to their undergraduate background, these engineers also have taken several graduate-level courses in one or more water-oriented technical specialty areas such as hydraulics, sanitary engineering, and hydrology.

Today's water resources engineering graduates are indeed different from conventionally-trained engineers of a decade ago. They also differ in some important ways from their contemporaries graduating in technical specialty areas today.

In general, today's water resources engineering graduates are more systems-oriented, more knowledgeable and aware of environmental and ecological factors, more suited to work in an interdisciplinary approach to problems, more concerned with making meaningful contributions and having an impact in their work, and more inclined to try new approaches to problem solving in an effort to do things better. *They are quite capable and highly-motivated individuals who have much to offer firms and agencies in the water resources area. Progressive firms and agencies seem to be well aware of the utility of today's systems-oriented interdisciplinary water resources engineering graduates and are eager to utilize them.*■

ANCHOR ON THE CASTLE

by Seymour Reitman

Among the revelations to confound the public image of American institutions is the occasional comment that the U.S. Army maintains a fleet larger than those of the U.S. Navy and Coast Guard combined. Even more stereotype shattering is the observation that the Army Corps of Engineers alone has a 2,600-vessel civil works fleet outnumbering those of the other services.

The Corps itself would be the first to admit this comparison is strictly numeric. Obviously, even the 525-foot long hopper dredge *Essayons,* the Corps' largest vessel, would be dwarfed alongside the hulking hull of an aircraft carrier and never match the swiftness of a Coast Guard cutter. To the Corps, though, she's the "queen of the fleet."

For a proper perspective, however, it should be noted that some 850 Corps vessels are really in the barge category. Only 43 are dredges, the largest type of Corps owned vessels.

The elite within the elite are the 16 sea-going hopper dredges belonging to the United States, all of them operated by the Corps. Thus, they represent a public investment in river and harbor maintenance, a type of work declined by commercial dredge operators; for no existing commerical dredge could be expected to withstand the rougher waters of the open seas encountered by the sea-going hopper dredges.

This innovative design of combining internal hopper bins with the typical dredge's suction lines and pumps permits the Corps to remove dredged materials to remote locations on shore or far out to sea. As further testimony to their seaworthiness the dredges *Davison, Hyde* and *Schweizer* (the latter a sidecasting dredge) sailed to Vietnam to provide navigable channels for ships supplying U.S. forces there. The *Davison,* last to come back, recently returned to her Portland (Ore.) Engineer District home after a 6-year overseas tour.

Newest of the hopper dredges is the *McFarland,* operating out of the Galveston (Tex.) District. Today's economic requirements for deep-draft freighters and tankers, not to mention environmental considerations, sometimes means carrying on dredging operations 21 miles out to sea, which the *McFarland* does by extending the entrance channels of the Sabine and Neches Rivers into the Gulf of Mexico.

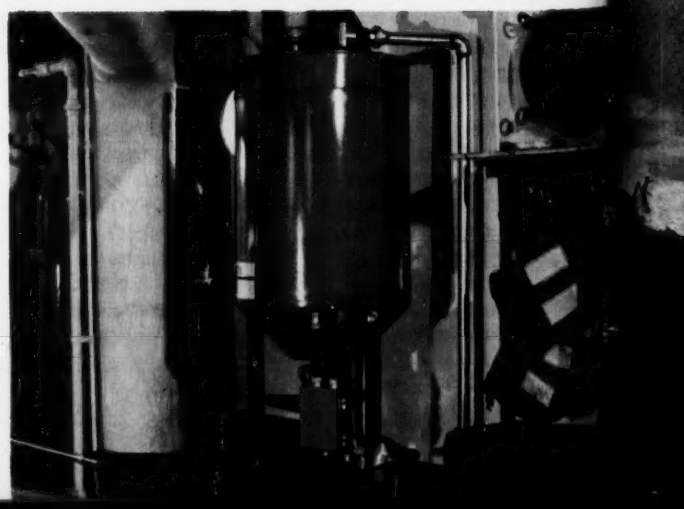
Built in 1967, the *McFarland* has the only triple capability among the "floating vacuum cleaners" — as their dredge crews refer to them. Besides her internal hopper bins, the *McFarland* has a revolving boom for sidecasting operations and the latest equipment for direct pump out (DPO).

Besides the *McFarland,* three other dredges were constructed solely for sidecasting and the four hopper dredges operating in the Great Lakes have had DPO capabilities added on through structural modifications.

The remainder of the hopper dredge fleet is scheduled for conversion to DPO capability, which permits the pumping of dredged material into a preselected remote on-shore location or diked reclamation area that will not interfere with normal environmental processes near the dredging sites.

Typical of the modern hopper dredge fleet is the "Markham," one of three operated by the Buffalo (N.Y.) District. Displaying none of the outward vestiges of the old hopper classes, the "Markham" could easily be mistaken for part of the sea-going maritime fleet were it not for her Army markings.

The pipeline dredge "Jadwin," belonging to Vicksburg (Miss.) District, has a "dustpan" suction head developed to remove sand and silt "crossings" built up by current shifts from one side of the river to the other. This type is mostly used to maintain navigable channels in the Mississippi and Missouri Rivers.

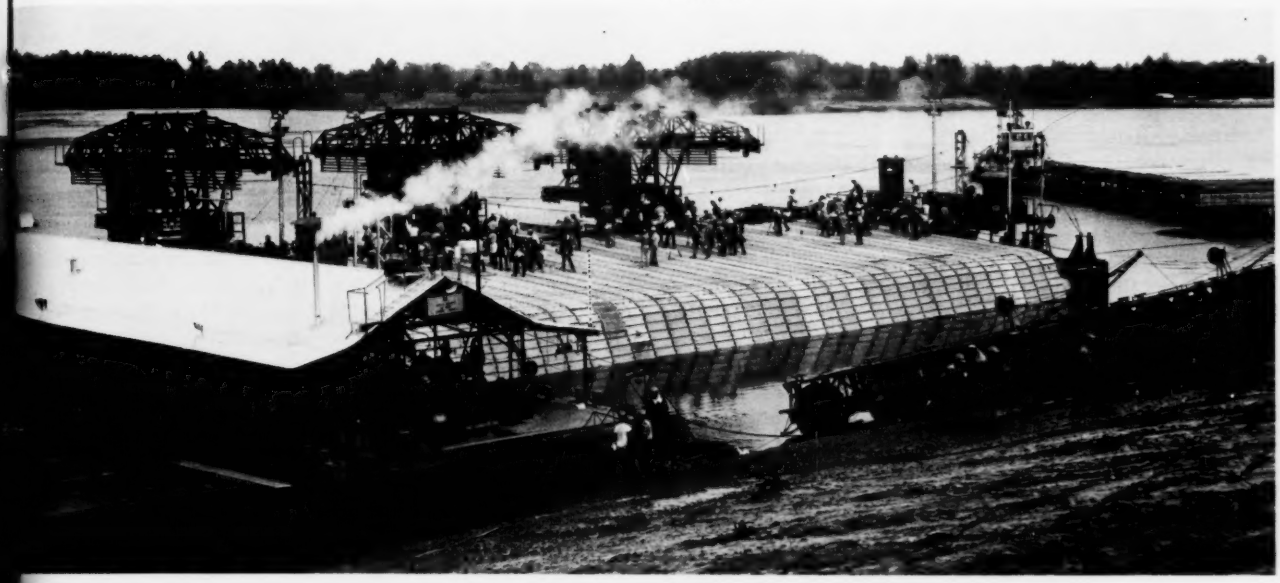


This below deck view illustrates how easily the latest lightweight sewage treatment system can be located aboard relatively small vessels. The 400-pound evaporator tank shown here is only 2 feet in diameter and 5 feet high.

It takes a combination of A-frame gate lifter to lift and a towboat to push around this over 70-ton gate leaf at the Louisville (Ky.) District repair station.

Center — Mattress-sinking barge workers tie concrete "squares" together as a multi-wheeled mat pulling rig hauls the launching cables ashore at a new work site. To the right is a tender bringing in a barge load of "squares" for the gantry cranes to transfer onto the sinking barge deck.

Below — The flying bucket of a bank grader scoops up dirt pushed down to it by five tractor dozers. To the right is a graded portion of river bank ready to receive the concrete mat. Two mooring barges hold the bank grader in position to move in or out from the bank.



The sidecasting technique was developed by the Corps to dispose of sand and silt dredgings from shifting shoals that continually form across many of our coastal inlets. This technique can only be used in areas where the littoral currents will keep most of the dredgings from drifting back into the channel being deepened.

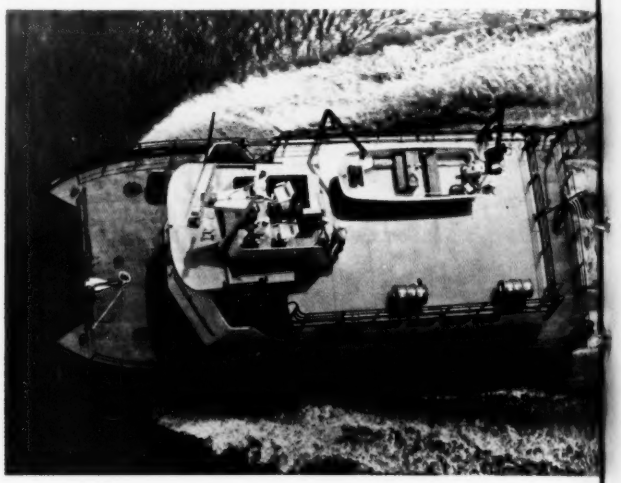
According to Bill Murden in the Office of the Chief of Engineers at Washington, the shallow-draft sidecasting dredge was designed from scratch with "astounding success." Up to the introduction of these sidecasters in 1965, privately owned boats and small commercial fishing craft were being repeatedly inconvenienced and sometimes damaged by trying to bump their way across these inlet shoals at low tide. The then accepted technique was to run landward with each incoming wave until the boat grounded. Given enough incoming waves the boat eventually surfed its way across the shoal. "Since that time," Murden observed, "we have found a way to keep these inlets open."

Aside from the ocean-going hopper and sidecasting dredges, the remainder fit into the pipeline dredge category. These flat-bottomed dredges never venture beyond the relatively placid waters of our major river systems and their interconnecting channels. These inland waterway dredges take their name from the lengthy pipeline they use to carry dredged material to remote shallow water areas away from the main channel. A series of pontoon barges supports the pipeline between the dredge and the discharge site at the other end.

Some of the pipeline dredges are of the "dustpan" variety, so-called because the wide suction heads used to dredge the river bottoms faintly resemble that well known household tool. Nozzles on the forward edge of the "dustpan" allow high pressure water jets to loosen the river bottom material which a centrifugal pump sucks up in a slushy mix of sand, silt and water. The mix is then discharged into the pipeline (ranging up to 34 inches in diameter) running away from the channel. This particular type of dredging head was designed by the Corps for use almost exclusively on the silty bottom of the Missouri and Mississippi Rivers.

Most common of these hydraulic dredges, however, is the "cutterhead," which has a revolving cutter at the end of its suction pipe or "ladder." This revolving cutter can loosen compacted clay, gravel and other hard materials that a dustpan cannot handle. Also, the cutterhead has a longer pipeline than the dustpan and can pump dredged materials to remote diked reclamation areas farther inland.

A low level aerial view of the 65-foot long survey boat Shuman, working out of the Philadelphia District, points up the distinctive twin bows of its catamaran hull. This split hull design offers a more stable platform for its electronic surveying equipment and reduces wake damage to the shoreline.



Two of the smaller cutterheads remain on permanent duty at two of our Alaskan ports. The larger cutterheads are utilized in the Mississippi, Ohio and Missouri Rivers, and in several other major waterways. Other cutterheads are used chiefly in the maintenance of navigable depths at recreation harbors that are part of multi-purpose water projects and in the approaches to locks.

The handful of yet smaller bucket and dipper dredges are used to scoop and dump dredged material much like the mechanical shovel equipment found ashore. The bucket dredge is basically a derrick with a clam shell at its boom end, whereas the dipper dredge is built like the familiar steam shovel and is used in a similar manner to dig into rocklike river bottoms.

Admittedly the various types of dredges constitute the most physically noticeable vessels due to their size, but they represent only a fraction of the Corps fleet.

While the reasons for continual dredging may be patently obvious, where and when to start and stop requires an expertise that only survey boats and their crews can supply. Until recent years all of these survey boats resembled the average privately owned cabin boat or fishing smack and operated at 10-15 mph. A good many were picked up long ago as World War II surplus Navy and Transportation Corps vessels. In fact, several of the districts still operate with the old 65-foot steel hull "T-boat" of World War II vintage. However, the latest acquisitions include computerized sounding equipment such as that mounted aboard the new *Gillette* survey boat used by the Wilmington (N.C.) District. Two similarly electronically equipped high speed aluminum

hull survey boats are being procured by the Mobile (Ala.) and Jacksonville (Fla.) Districts. Jacksonville's new boat, in addition, will be the first Corps owned vessel to operate with gas turbines instead of the standard diesel engines.

Truly unique among the later survey boat designs is the *Shuman,* the Philadelphia District's 65-foot long aluminum catamaran hull designed to operate in the lower Delaware River and Chesapeake Bay as a shallow draft, high speed vessel. The *Shuman,* commissioned in June 1970, replaced the *Liston* which had been in service continuously since 1930.

Survey boats customarily have been used to make soundings describing how much and what type of underwater material should be removed to maintain specific channel depths. Surveys also supply data for engineering estimates used to design a navigation channel or to determine the quantity of channel dredgings to be used as new fill to replace erosion from beaches. The planned acquisition of swifter hulls and automated data collection equipment is gradually reducing the need for survey boats to remain overnight at distant survey sites and the number of survey personnel needed.

Swift hull designs are also used for the all-around launch, which does occasional surveying, but mostly serves as a utility transport. One Corps employee characterized it as the district's "bus service" vessel for personnel, supplies and small equipment.

The launches carried aboard the deeper draft hopper dredges are named after their parent vessel in true maritime style, such as the *McFarland II* and the *Hains Jr.*

Not quite obsolete, the era of the maneuver boat and needle flat belongs to the fast disappearing wooden wicket dam. The wickets of these movable dams can be raised or lowered as the flow of the river goes up or down.

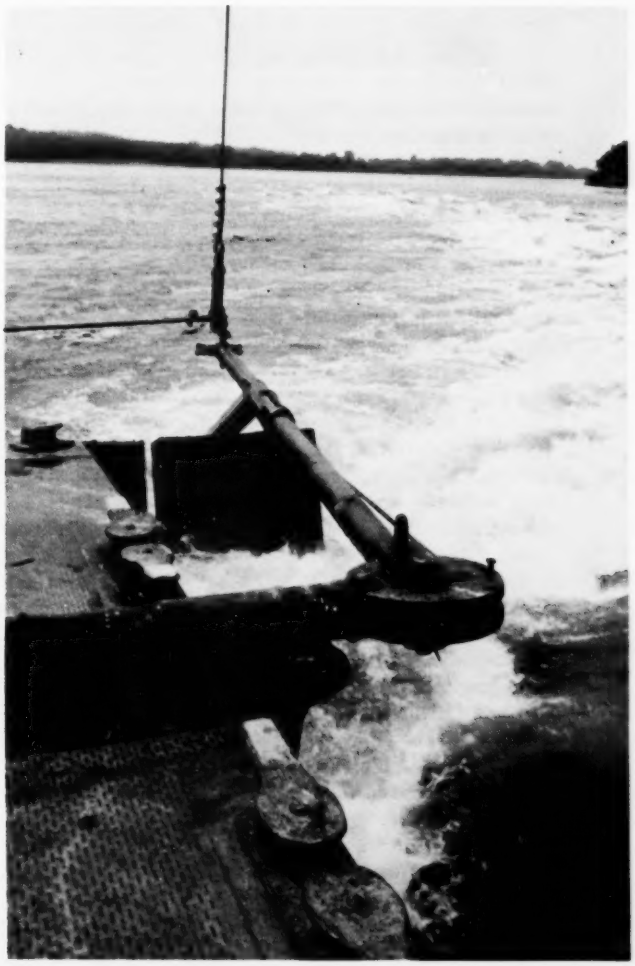
The generally smaller patrol boat resembles the recreational boater's waterskiing and fishing runabout. Its name implies exactly what it does, patrolling specific waterways, harbors or reservoirs to check channel markers, find navigation obstructions and oil spills or inspect work being done under a permit. As "policers of the waterways," patrol boats are often operated by the local ranger around Corps recreational lakes.

Even smaller in size are the vessels referred to, for lack of a more appropriate designation, as "small boats." Serving a host of utility purposes, they come in various lengths from the common rowboat on up to anything that's under 16 feet. Like many of the Corps' floating plant items, they can be purchased "off the shelf."

Quite uncommon, on the other hand, are the flat-bottomed vessels evolved by the Corps over the years to suit specialized local usages, such as the "maneuver boat" and "needle flat."

Looking like a revolving derrick hoist mounted on a bargelike hull, the maneuver boat is peculiar to the Ohio and Illinois Rivers where the old movable wicket dams are still found.

Since the early days of the settlers, these rivers have been traditional transportation routes for large areas of the Midwest. However, the erratic nature of these rivers



Divers like Jeff Straney do the underwater repair of wicket dams without interrupting the flow of water needed to "lock through" river traffic.

tends toward sudden floods and extreme variations in water levels.

This kind of hydrologic temperament called for a system of water level control with the capability of rapidly responding to fluctuating levels. So the movable dam concept came to the United States — and the maneuver boat with it.

The distinctive feature in this type of dam is the portion called the navigable pass, which is filled with 10-inch thick, 4-foot wide oaken wickets spaced about 4 inches apart. Each wicket is individually hinged to a supporting oak and concrete foundation sill on the downstream side. Varying numbers of these wickets may be raised or lowered at any time by hooking into them with the hoisting equipment on the approximately 60-foot long maneuver boat, braced against the upstream side of the wicket line with the help of a shore line cable and a "pusher boat."

The mechanism for "throwing" the wickets is a tubular outrigger extending off the bow of the maneuver boat with a swiveling sheave at the end. A removable tripping hook is attached to the sheave and operated by a rope line passing over the sheave.

When Lockmaster P.B. "Buck" English first came to work on the Ohio River, he recalls, the job of "throwing" a wicket was all done manually. A dam tender would stand at the bow of the boat and loosen the wicket head with a long-handled hook by pulling the wicket upstream several inches. Sometimes he was yanked off the deck and swept downstream through an opening between the thrown wickets as the force of the rushing water swiftly slammed his loosened wicket down against the dam's sill.

During low water periods the narrow spaces between the standing wickets are closed off by inserting square "needles" cornerwise. The needles are 4- to 6-inch square timbers hauled between the wicket line and shore on "needle flats," which are 48-foot long open deck barges used strictly for this purpose. A second needle flat always stands by at each wicket dam loaded with "slats" — metal strips used to block the flow between wicket gaps too wide for the narrow needles.

Unlike the modern concrete spillway dams slowly replacing them, the wicket dams have wooden parts and movable hinges that require much more repair work. Since the sliding hinge mechanisms of the wickets are constantly underwater, the only way not to interfere with the constant river traffic is to use divers operating from maneuver boats for repair operations.

Thus, a long standing policy of the Corps has been to try out every new employee at its movable dams who'll consent to don a diving suit. Many do not consent. And a good percentage of those who do, never qualify.

The problem, as English explains it, is the terrific pressure from the compressed air used to keep the watertight suit from leaking or collapsing underwater. "Takes a tough man! I've seen 'em come up bleeding through the nose and ears from the pressure," he observed.

That's what makes Jeff Straney of the Louisville (Ky.) District an unusual man. Part of the regular crew at

Lock 46 on the Ohio — located at Owensboro, Ky. — Straney had been diving for over 40 years, then the district office finally "forced me to go easy since I hit 65," Straney said.

He showed off his heavily dented helmet as a proud relic of the many years spent working underwater around wickets. Years of diving experience also taught Straney to conserve energy in small ways, such as placing his weight on the diving ladder prior to adding the 75-pound lead-weighted belt. This action takes the strain off his waist until just before he lowers himself into the more buoyant water off the maneuver boat.

Meanwhile, up river at the Louisville District repair station, a pusher type boat is being used as a utility towboat. Officially classed by the Corps as tenders, the district employees call them "mules." These mules got their name during World War II when everyone began calling them "sea mules" due to their all-around versatility overseas.

As a district facility, the Louisville shop also has a towboat named the *Person* to move around an 18-ton capacity "whirley" derrick boat and an even larger 100-ton capacity A-frame gate-lifter boat. The need for both a whirley, which is a revolving-type derrick, and an A-frame is pretty obvious after watching the A-frame's steam crane manhandle huge mud-laden 70-ton and heavier lock gate-leaves from one location to another. The smaller whirley boat seems just right for lifting the relatively light "horses" stored in the district's repair station next to the McAlpine Lock and Dam on the Ohio. Station Superintendent C.E. Rohde explained that "what the men call 'horses' are really poiree-type trestles (triangular supports) used to hold panels in place to form a cofferdam for dewatering an underwater area in need of repair."

The Louisville District's dredging requirements are taken care of through annual courtesy visits by the St. Louis District's pipeline-cutterhead dredge, the *St. Genevieve*. Thus the *Person* is the largest self-propelled vessel needed in the Louisville District. Curt Leitch, her master and pilot, says his small 10-man crew is always available to "handle emergencies" by operating on what's known as a "square watch," or two half crews alternating six hours on and six hours off around the clock. That means splitting watches so that a pilot and engineer are available on each watch. Similar to commercial towboats, the *Person* contains her own on-board crew's quarters and a galley for the extended field trips that are frequently required.

It's during these same field trips that Superintendent Rohde hangs his engineer's hard hat in his floating office barge — complete with desks, filing cabinets, drafting board and other paraphernalia vital to continuing the administrative functions of the superintendent's office on whichever river site is being worked.

Mention of an office barge reminds one that the square-hulled, flat-bottomed barge design actually constitutes over half of the Corps' civil works floating plant. The ubiquitous barge design is present everywhere along the navigable inland waterways of the continental United States. It includes the common deck cargo barge as well as the less common classes, variously described as anchor, dump, mooring, fuel, water, service, shop, store, survey and spar barges.

Nowhere do they come into more prominent display than during the summer low-water season on the lower Mississippi River, for the meandering nature of the Mississippi's lower reaches (from Cairo, Ill. to below Baton Rouge, La.) creates constantly changing river conditions. For many years the Corps has been attempting to stabilize the Mississippi's channel against the bank cave-ins, crumbling levees and formation of seasonal sand bars by applying, among other methods, a flexible concrete mattress at selected sites.

The only operation of its kind in the world, this program requires the sinking of jointed concrete mats against the sloping underwater banks of the lower Mississippi, usually where the current meets the downstream side of a bend.

"Squares" of 20 individual concrete blocks, connected by embedded wire cables, are poured at mat-casting fields strategically located at about 100-mile intervals along the river. Special purpose trailers carry the "squares" down to the loading out dock, where a mattress loading crane transfers them to deck cargo barges for towing to the work site.

Up to 15 barges may be pushed to the site by a single towboat, which then transfers them over to a smaller tender for moving individual barges to a specially constructed piece of floating equipment called a mattress sinking unit. This unusual looking barge design, developed by the Corps, carries gantry cranes that transfer the 3,200-pound squares from a supply barge to its own deck. The mattress-sinking barge crew attaches each square to the preceding one by stringing them onto parallel wire launching cables anchored to the bank. When a "launch" or section of mattress measuring about 140 by 25 feet has been fabricated, the mattress-sinking barge winches itself out from under the completed mattress in order to "launch" it. Once a predetermined number of "launches" are finished, the cables are cut and a towboat or tender repositions the mat-sinking barge and its one or two mooring barges to an adjacent point upstream where the next mat will overlap the last one by at least 15 feet.

Meanwhile, a unique looking bank grading unit moored offshore has been busy preparing the next bank site with the help of several tractor-dozers, which feed dirt downhill to the bank grader's flying drag line bucket.

Since none of the barge fleet has its own motive power, several towboats and tenders are provided by the Vicksburg (Miss.) and Memphis (Tenn.) Districts, which share responsibility for this annual operation.

Both districts are part of the Lower Mississippi Valley Division headquartered at Vicksburg, which hires a large force of seasonal workers who actually live with their work as the mat revetment operation moves from site to

A new "air boat" concept is being used in southern inland waterways to reach hitherto inaccessible areas infested with aquatic weeds such as this patch of water hyacinth. An operator sprays the weeds as the pilot skims his airplane propeller driven flat boat over the vegetative mat.

site along the river. This mat laying work force is housed in a variety of different size bargelike "floating hotels" called quarterboats. Smaller units, called bunk barges, have no galleys, laundries and recreation facilities of their own and are anchored next to separate mess, laundry and recreation room barges in a floating community complex.

While the Corps handles the unique mat revetment operation on its own, it prefers to let private contractors do the majority of the dredging and diking work that is also a part of its flood control program along this stretch of the Mississippi.

This need for the Corps to be engaged in actual operations also prompted the varied designs used in creating the most unusual of all vessel categories — the aquatic growth control boat. It was developed to combat the spread of the water hyacinth aquatic weed.

Brought to the United States as an exhibit, the deceptively pretty but dangerous South American water hyacinth was unwittingly permitted to escape the confines of a horticulture show during the New Orleans Cotton Exhibition of 1884. Given the nearby subtropical growing conditions similar to its home climate, the water hyacinth soon exploded into the most prevalent aquatic weed of the Southeast. In some areas it quickly formed solid mats of vegetation from bank to bank — solid enough to support a man's weight without yielding.

Along with the alligator weed, today's water hyacinth infestation is endemic from the coastal tidelands north to the hard freeze line all the way from North Carolina to eastern Texas. The rapid spread of these aquatic weeds has become so damaging to inland navigation, pleasure boating, fishing and flood control that Congress finally requested the Corps to investigate methods of controlling the infestation. These methods have been alternating over the years between mechanical attempts to slice a navigable swath through the vegetative mat and various chemical spray techniques.

Over the years the Corps has experimented with varied pieces of shallow bottom floating equipment in order to penetrate the almost inaccessible reaches of land-locked lakes and small streams surrounded by the swampy terrain in which the densest aquatic weed growths are found. These floating units range from tree limb chippers and gangs of rotary saws mounted on bargelike hulls to the airplane propeller-powered "air boat" used to spray these weeds in the Jacksonville District. With its airplane propeller engine mounted above deck, the flat-bottomed air boat can skim and skip over the surface of otherwise impenetrable water hyacinth patches.

The New Orleans District has even used an amphibious tractor built around the frame and engine of a garden cultivator, substituting high flotation wheels and mud cleats for its regular wheels. Attached by drawbar to a small skiff or rolling dolly, the cultivator's plow handles can be held by a Corps employee as he "plows" through weed infested mud flats or shallow water.

The latest attempt to control the spread of these unwanted aquatic plants is an experimental boat being designed to attack them with laser beams.

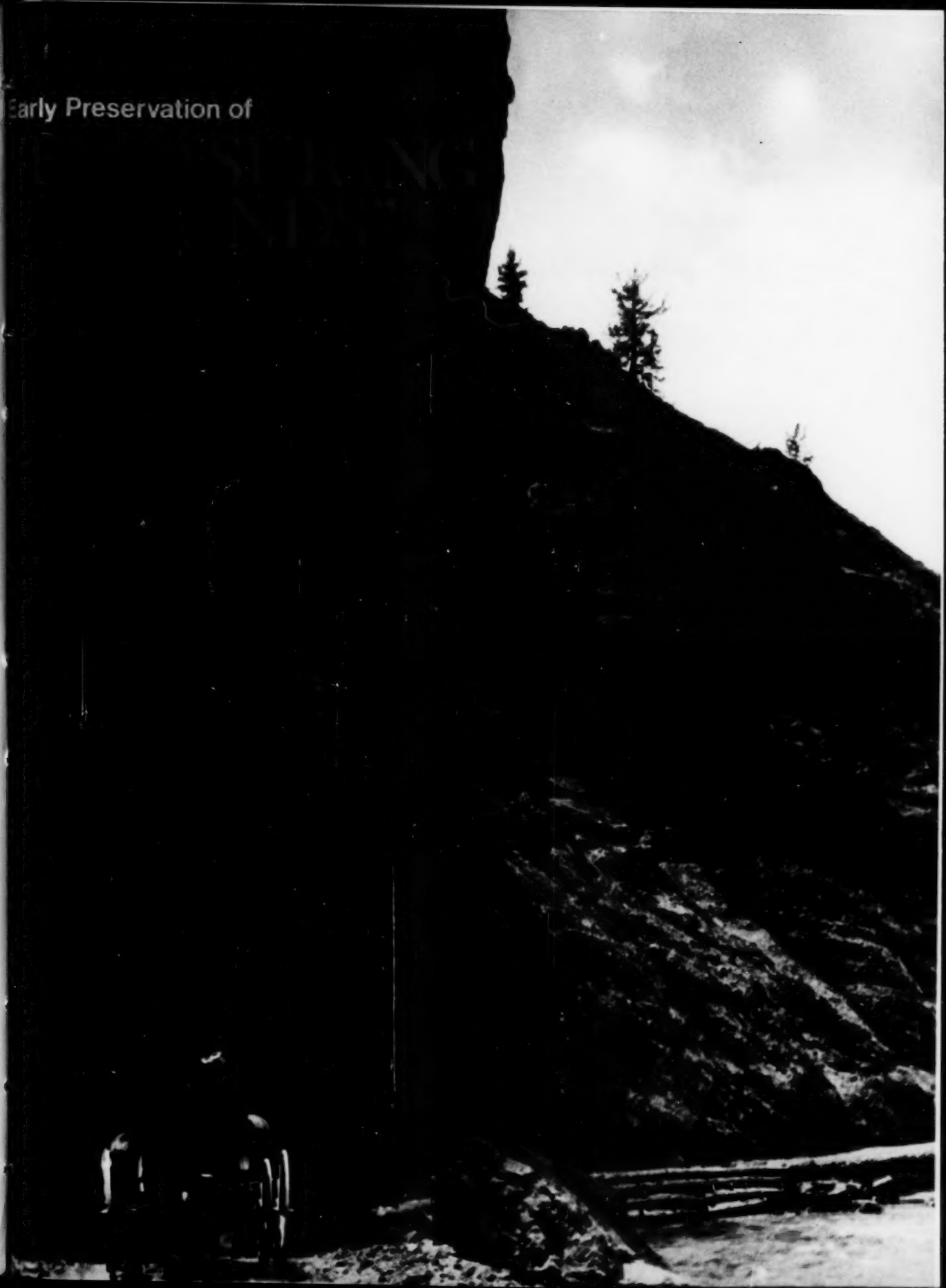
Numerous as they are, the different methods of aquatic plant control tried by the Corps do not equal the variety of floating plant it owns and operates. Still other types of specialized vessel categories abound within the Corps fleet. They conform in size, shape and capacity to the peculiarities of the missions the Corps is often asked to perform. An obvious example is the debris boat, as necessary to many districts as their towboats. Some of these were formerly known by the more colorful names of drift collectors, snagboats and snag barges. All of them, though, have the never ending mission of removing debris and snags from our harbors and major rivers.

Other categories include the drill boats that engage in underwater drilling, and the boathouses that serve as floating boat covers. And finally there exists that host of truly unclassifiable floating items the Corps equipment list refers to as "miscellaneous." Their prosaic titles, however, easily describe their purposes in direct, simple fashion as fire boats, pile drivers, floating drydocks, pontoon bridges and the like.

As one of the largest construction agencies in the world, the Corps operates a floating version of almost any activity conducted ashore. Its scope is so diverse that the Corps is repeatedly faced with unique requirements calling for innovative equipment designs. Its personnel are continually required to develop expertise in unusual fields — such as the operations associated with the mat revetment program, the control of aquatic plant infestations and the variety of specialized dredging requirements to maintain navigable depths against rapid and unpredictable shoaling.

Several years ago the distinctive role of these civilian sailors was recognized in the Corps through the issue of uniform caps similar to those worn by American maritime officers. The difference was the new heraldic device on each cap — a gold anchor superimposed on a silver castle, traditional insignia for Corps of Engineers personnel.

Although the cap insignia is relatively recent in age, Corps vessels began plying our domestic waters in 1824. That was the year Congress funded snagging operations on the Ohio and Mississippi Rivers. From then on, an anchor was destined to appear on the Corps castle. ■


Early Preservation of

by Francis X. Kelly

In 1883, Congress appropriated $29,000 to be expended under the direction of an Engineer officer for roads and bridges in Yellowstone National Park.

The Nation is celebrating this year an anniversary of an idea that took root in the West and spread around the world — the 100th birthday of Yellowstone National Park and the Centennial of the concept of national parks.

On March 1, 1872, President U. S. Grant signed the bill which set aside more than two million acres of what was then Wyoming and Montana Territories "... as a public park or pleasuring ground for the benefit and enjoyment of all the people." With the signing of this proclamation the Nation's, and the world's, first national park was established.

The need to preserve this vast natural wilderness became apparent as early as the 1860s because gold and other minerals were found in the Rocky Mountain area. Also, numerous expeditions set out to see the natural wonders which had been reported in Indian folklore and by the few white men who had visited the region as early as 1807.

In 1870, the Washburn-Langford-Doane Expedition was the first party to explore and record what they had found in this region and their party is credited with the idea of creating this first national park. While still exploring the area, they had considered staking claims and constructing facilities to attract what they knew would be thousands of visitors willing to pay to see the geysers, petrified forests, lakes, canyons and wildlife.

Their thoughts of commercialization were overcome, however, by their desire to preserve the entire region as a public park for all the people.

Following their expedition, these men, headed by Nathaniel P. Langford, wrote articles for magazines and newspapers and lectured far and wide to all who would listen concerning the beauty of the Yellowstone area and the need to set it aside as a "playground for the people of our country."

The cry was heard and the Federal government eventually responded by establishing Yellowstone as the first national park in the world.

In the meantime many who had heard members of the Langford group felt there would be no harm in claiming areas within the proposed park, and if the park were not created they would be well established and could make great personal profits.

Unfortunately, following the creation of Yellowstone National Park there was no means available to protect the park from encroachment by private developers, fortune seekers, trappers and hunters.

Although the park was placed under the jurisdiction of the Department of the Interior, it had neither the laws, funds nor personnel to supervise the region. The recourse was to ask the Army to operate and protect the area.

Beginning in 1886, and continuing for more than 30 years, the Army provided superintendents to administer Yellowstone as well as other new national parks and monuments authorized for establishment by the Congress.

Meanwhile, conditions in Yellowstone required immediate attention. Squatters and land-grabbers had begun what they hoped would become a new-type bonanza — setting up tourist attractions and accommodations. Buildings, roads, and bridges — constructed as early as 1870-71 to accommodate the needs of the early trappers, lumbermen, prospectors and visitors — required maintenance or replacement, and vandalism of natural formations had taken its toll.

In spite of repeated attempts within Congress to appropriate money for surveying the park boundaries, the construction of roads and bridges within the park, and for protecting wildlife and natural features, funds were not made available until 1878.

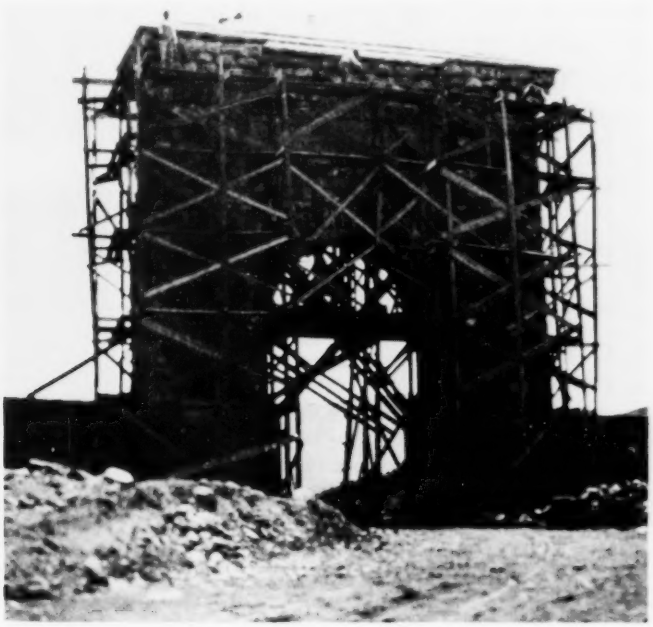
Five years later, in 1883, Congress appropriated $40,000 of which $29,000 was to be expended "under the direction and supervision of an Engineer officer ... for the construction and improvement of roads and bridges within the park." With the appropriate bill and the ensuing appointment of First Lieutenant Dan C. Kingman, Corps of Engineers, came the first realistic move for developments in Yellowstone.

Mr. Kelly, formerly chief of news media of the National Park Service, is now assistant for conservation liaison, Public Affairs Office of the Office of the Chief of Engineers.

All photos supplied by the National Park Service, U. S. Department of the Interior.

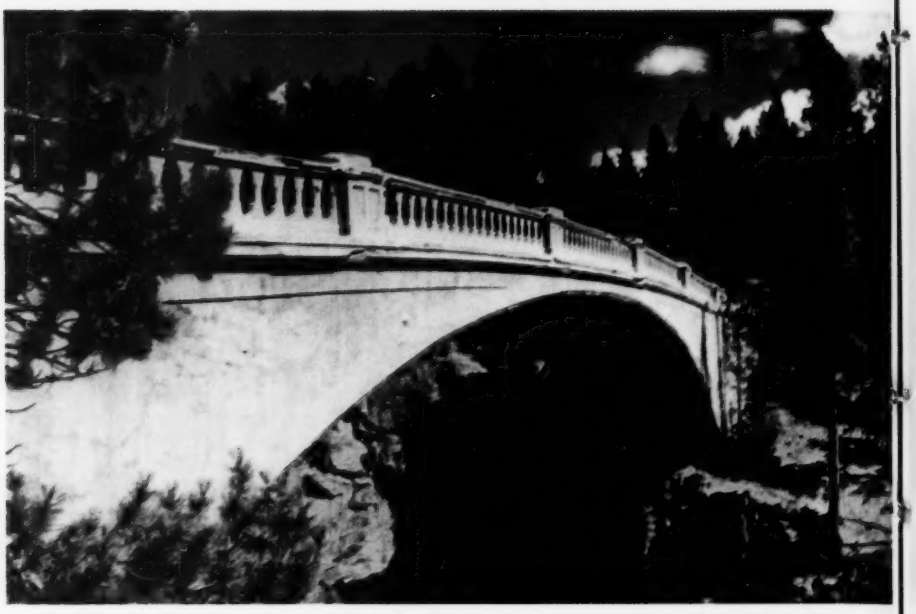
The stone buildings of this first permanent military post, established in 1891 at Yellowstone National Park, became the nucleus of the Park's present headquarters.

Captain Hiram M. Chittenden (later Brig. General), Corps of Engineers, was one of the first Corps officers assigned to Yellowstone. Many of the Park's roads, bridges and buildings were designed and constructed under his supervision and stand today as monuments to his engineering ability.



This arch constructed by Chittenden still stands today. President Theodore Roosevelt dedicated the arch in 1903.

A typical bridge constructed by the Army during the early days of the Park.



The Chittenden Bridge is a memorial to Chittenden's work.

Visitors were attracted to Yellowstone as early as 1880 partly because of the supposed medicinal value of the geysers. Visitors today would not be able to enjoy these geysers in their present state if the park had not been protected against commercialization by exploiters.

President Theodore Roosevelt and his aide, Captain Pitcher, during their visit to Yellowstone.

The President's Cavalry escort at Yellowstone.

This road, constructed during the Corps' tenure at Yellowstone, was part of a network which eliminated the need for railroads in the parkland.

Although the first assignment of Army troops for the protection of wildlife and natural features did not occur for another three years, Army Engineers assigned to the park recognized the importance of preserving the natural features of the area and strongly opposed the construction of a branch railroad in the park connecting with the main line of the Northern Pacific.

New policies for the operation and control of the park were established by the newly appointed military guardians. Their laws and regulations, although considered more harsh and arbitrary than those which existed earlier, had a lasting effect on the park. Poachers were arrested and expelled from the park and the natural features of the area were being protected from vandalism during the tourist season. Many of the policies established by the military remain today as national park policies.

Following the authorization and establishment of Yosemite, Sequoia and General Grant National Parks in California (the latter is now a detached section of Kings Canyon National Park), the Secretary of Interior once again requested the Secretary of War to provide Army troops "... to prevent timber cutting, sheep herding, trespassing or spoliating in particular ...."

On April 6, 1891, Troops "I" and "K," 4th Cavalry, were detailed for duty in Yosemite, Sequoia and General Grant National Parks.

As conditions improved both within the national parks and areas surrounding their boundaries, and the population began to accept the idea of preserving the wilderness areas for the future, military troops were finally withdrawn and the newly created National Park Service assumed responsibility for the parks.

Many of the national monuments, national battlefields and other historic areas which were later to become elements of the National Park System remained under the control of the Army as late as 1933.

The Engineers, in building and maintaining the roads and bridges in the first national parks, continued their tradition of responding to the Nation's needs. At the same time, Army cavalrymen assumed responsibilities that are encompassed today by the duties of the national park rangers. H. Duane Hampton points out in his new book, *How the U. S. Cavalry Saved Our National Parks*, that the Army played a major role in preserving the national parks and the concept of "national park" when Congress was about ready to abandon the idea. Without this protection in the early days of the national parks, people would not be able to enjoy these "pleasure grounds" as they exist today.■

Events, Deeds & Deliberations

Dam Safety Law Arrives

The formidable task of inspecting every potentially dangerous dam in the the country has been handed to the Secretary of the Army, acting through the Chief of Engineers, in a dam safety law signed by the President in August.

Submitted to the President as H.R. 15951, the new law expresses congressional concern over possible future disasters similar to the recent dam failures that triggered the Rapid City, S. Dak., and Buffalo Creek, W. Va., tragedies. The intent is to assess the scope of the problem by asking the Secretary of the Army to report back to Congress by July 1, 1974.

The report will include an inventory of all United States dams, a review of each inspection made and recommendations for a comprehensive national program of inspection and regulation of dams. Furthermore, each inspection review will include recommendations forwarded to the Governor of that State and information on their state of implementation.

Besides a comprehensive national program, the Chief of Engineers will also be expected to describe the respective responsibilities which should be assumed by Federal, State and local governments and also by public and private interests, including cost sharing.

The magnitude of the problem is such that Congress has written several exclusions into the law. Thus, none of the Federally-owned dams need be inspected by the Corps of Engineers that are already under the jurisdiction of the Bureau of Reclamation, the Tennessee Valley Authority, International Boundary and Water Commission, or those licensed under authority of the Federal Power Act. However, both the International Boundary and Water and Federal Power Commissions may request inspections by the Corps.

Neither will the Corps look at any dams already inspected by a State agency within the calendar year preceding the date of this law provided the Governor of that State asks for an exclusion.

Also excluded are dams which do not pose a threat to human life or property.

Since Congress estimates over 28,000 non-Federal dams in existence, the scope of the program was concentrated by defining a dam as an artificial barrier 25 feet or higher used to impound or divert water, or else capable of impounding 50 or more acre-feet. The typical farm pond would not be a candidate for inspection because the new law specifically excludes any water barrier not over 6 feet high or with a storage capacity not over 15 acre-feet.

Results of each inspection will be reported to the Governor of that State in which the dam is located when the inspection is completed, unless any hazardous conditions are found during the inspection. Then the Governor is to be notified immediately.

Deciding whether any dam constitutes a danger to human life or property will depend on considering such possible occurrences as overtopping, seepage, settlement, erosion, sediment, cracking, earth movement, earthquakes, failure of bulkheads, flashboard, gates on conduits, or any other conditions that exist or might occur in the vicinity of a dam.

Although the inventory report to the Congress is due in 1974, the intent of the dam safety law is to complete the program by having the Corps of Engineers continue to inspect all dams described in the legislation. Only then will its authority expire.

Meanwhile, Congress will have a better opportunity to appreciate the full scope of the situation after two years of Federal inspection experience.

Seattle Splits Samples

Seattle's Metropolitan (Metro) Council is experimenting with a new sample-splitting program in an attempt to develop accurate water quality monitoring data.

Metro's water quality laboratory divides samples from a specified body of water and sends them off to other water monitoring units. Comparison of data collected and methods used will contribute toward development of uniform analytical procedures. Metro hopes this program will create standardized results among the cooperating laboratories.

Corps Turns On "Instant River" for Olympians

A month before the first such Olympic event ever held, the Corps of Engineers helped the U. S. Olympic White Water Slalom Team paddle toward Augsburg, Germany, by transforming western Maryland's Savage River into a sudden torrent of boiling water for the combined U. S. National Championships and Olympic White Water Trials.

Little more than a rill among the rocks most of the time, the trickling Savage briefly lived up to its name when the Baltimore Engineer District opened the flood gates at the Savage River Dam. Opening the dam's two hydraulically operated slide gates that control the horseshoe-shaped outlet tunnel's rate of flow permitted the mild 40 cubic feet per second (cfs) Savage to change into a roaring, raging 850 cfs river of white water.

This do-it-yourself Corps action on behalf of the canoe and kayak racers raised the water level almost 2.5 feet (from 1.42 to 3.8), dangerously close to the four camera platforms built out over the rocks by a TV network.

Some 12,000 spectators, largest American crowd in the history of the sport, trekked and shuttle-bused their way along the narrow, winding mountain road leading to the rocky banks of the Savage — part of the Upper Potomac River Basin.

Immediately after selection of the U.S. Olympic team, the Savage was hydraulically returned to a placid 30 cfs as the water subsided to a depth of 1.4 feet.

This is not the first time the Savage has been transformed for special race weekends. According to Col. Louis W. Prentiss, Jr., district engineer, the 20,000 acre-feet of storage capacity behind the Savage River Dam makes it relatively easy for the Corps to create an "instant river."

Flash Point Zero

Now, galley cooks can be reassured their molasses-flavored baking beans won't explode and lockmasters can breathe easier as molasses-laden barges come through on tow.

The necessity of having a *dangerous cargo* label for bulk shipments of molasses may first have come up in the galley where ages of use near open flames and in heated ovens failed to produce an explosion.

But come up it did, and once the question of combustibility reached official levels a review of literature on flash points and manufacturer's information on the nature of the product was on. Next came a study of vessel accident histories and reports of flash point tests. Finally, when no evidence materialized that molasses has a flash point or that it gives off flammable vapors, vessels carrying bulk molasses were removed from tank vessel and bulk dangerous cargo restrictions.

This rocky rill bears little resemblance to the roaring river on the front cover — yet both views were shot along the same stretch of the Savage.

Two Agencies Will Issue Golden Eagle Passports

Under the new Golden Eagle Passport program, anyone with a passport and those accompanying him may make an unlimited number of entries into areas administered by the National Park Service and the U. S. Forest Service, the only two agencies authorized to collect park "entrance fees." The passport costs $10 and among the places it will be available for 1973 are all first and second class post offices.

The Bureau of Sport Fisheries and Wildlife, the Bureau of Land Management, the Bureau of Reclamation, the Army Corps of Engineers, the Tennessee Valley Authority and the U. S. Section of the International Boundary and Water Commission (U.S. and Mexico) do not charge entrance fees but are authorized to charge for use of special recreation facilities such as camping sites. National Parks and Forest Service areas also are authorized to charge "user fees" in addition to their "entrance fees." The *regular* Golden Eagle Passport will not waive any "user fees."

Holders of a special passport called the Golden Age Passport, available free to anyone 62 years of age or older, will get a 50 percent discount on all "user fees" at all Federal recreation areas and free entry into all "entrance fee" areas.

The Corps charges $1 to $2 camping fees at about 125 of its more fully developed campgrounds in 21 different States. The 50 percent discount will be allowed for the Golden Age Passport holders at these sites. A list of these Corps campgrounds is in a booklet called "Lakeside Campgrounds," available from any District Engineer Office.

The charging of recreation user and entrance fees is based on the principle that those using the resources should pay more for them than those who do not. Up to 40 percent of the funds from the program can go for improving and promoting the collection system and the remainder may be used for "any authorized recreation function" by the collecting agency.

Protecting the recreation areas from vandalism has been a fringe benefit to charging fees. Would-be vandals tend to have more respect for something for which they have paid. They also tend to cause less destruction in areas where they come into contact with uniformed officials as they do in recreation fee areas. Past experience with the Golden Eagle Passport proved that the annual permit is more economical for frequent users of National Parks and for large families.

The projected Federal revenue for all 8 agencies from passports and daily user and entrance fees in 1973 is $20 million.

Lake Texoma First with Most

Water Spectrum's Summer 1972 issue named Georgia's Lake Lanier as first in total visitations at lakes under Corps management. Lanier is currently first in annual visits, but its recording of the 100-millionth visit in July 1971 was surpassed in 1965 at Texas-Oklahoma's Lake Texoma. The Tulsa District reports the cumulative total there had reached 169,231,000 visits by June this year. Our apologies to Texoma and to those who made the additional 69 million visits.

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Workshop-In-The-Park

A booklet describing outside-the-classroom park sites used as combination nature-culture environmental workshops is one of the latest educational innovations being introduced for American youth.

Instructions on where and how to run such an outdoor workshop are in *A Guide to Planning and Conducting Environmental Study Area Workshops.* Jointly produced by the National Park Service and the National Education Association, the new 50-page guide also discusses the key element in this program — National Environmental Study Areas (NESA). There are over 80 NESA currently available for outdoor school use in the National Park System besides those located on other government and private lands.

The guide may be purchased from the National Education Association, 1201 16th Street, N.W., Washington, D.C. 20036 .

Music for Fish Turns Them Off

Disc jockeys from 24-hour radio station WGH in Hampton, Va., are inviting fish in the James River to listen in on today's country-western and rock music hits. So far, the fish are refusing the invitation and at the same time avoiding the machinery from the Virginia Electric & Power Company's (Vepco) new Surry nuclear power plant located across the river from Jamestown.

The company installed four underwater speakers to keep croaker, spot and flounder from swimming into the area from which water is pumped to cool the condensers of the 1.6 million-kilowatt plant. The fish, most of which are fingerlings, could jam the plant's delicate machinery and kill themselves.

The experiment seems to be working because the sound waves are varied. If the sound was one unvarying tone or a series of tones, the fish would become accustomed to the noise and no longer be frightened by it, according to Danny Dotson, a 26-year-old Vepco technician. He first tested the idea with goldfish in his bathtub and made later tests in a pond.

Rainborne Pollution

Rains falling through polluted air may be compounding already existing watershed pollution problems. Mounting quantities of sulphur and nitrogen oxide in the air may be chemically converted into strong acids in the atmosphere. These acids, in turn, could be washed to earth and into rivers and streams by the "gentle rain."

Three scientists who studied a seven State area in the northeastern United States found that rainfall was 10 to 100 times more acid than they might have expected. They speculated that U. S. rainfall may be reaching the acidic proportions of a similar situation in Sweden.

The acidic rainfall in Sweden's watersheds was credited with causing a greater loss of nutrients from the soil, hampering growth of forests, corroding buildings, and in some instances killing salmon and trout. The acid rainfall there was linked to industrial air pollution carried by prevailing winds.

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Animal life, sometimes obvious but often small and inconspicuous, plays important ecological roles. An environmental inventory will identify habitats of endangered species. *See page 1.*